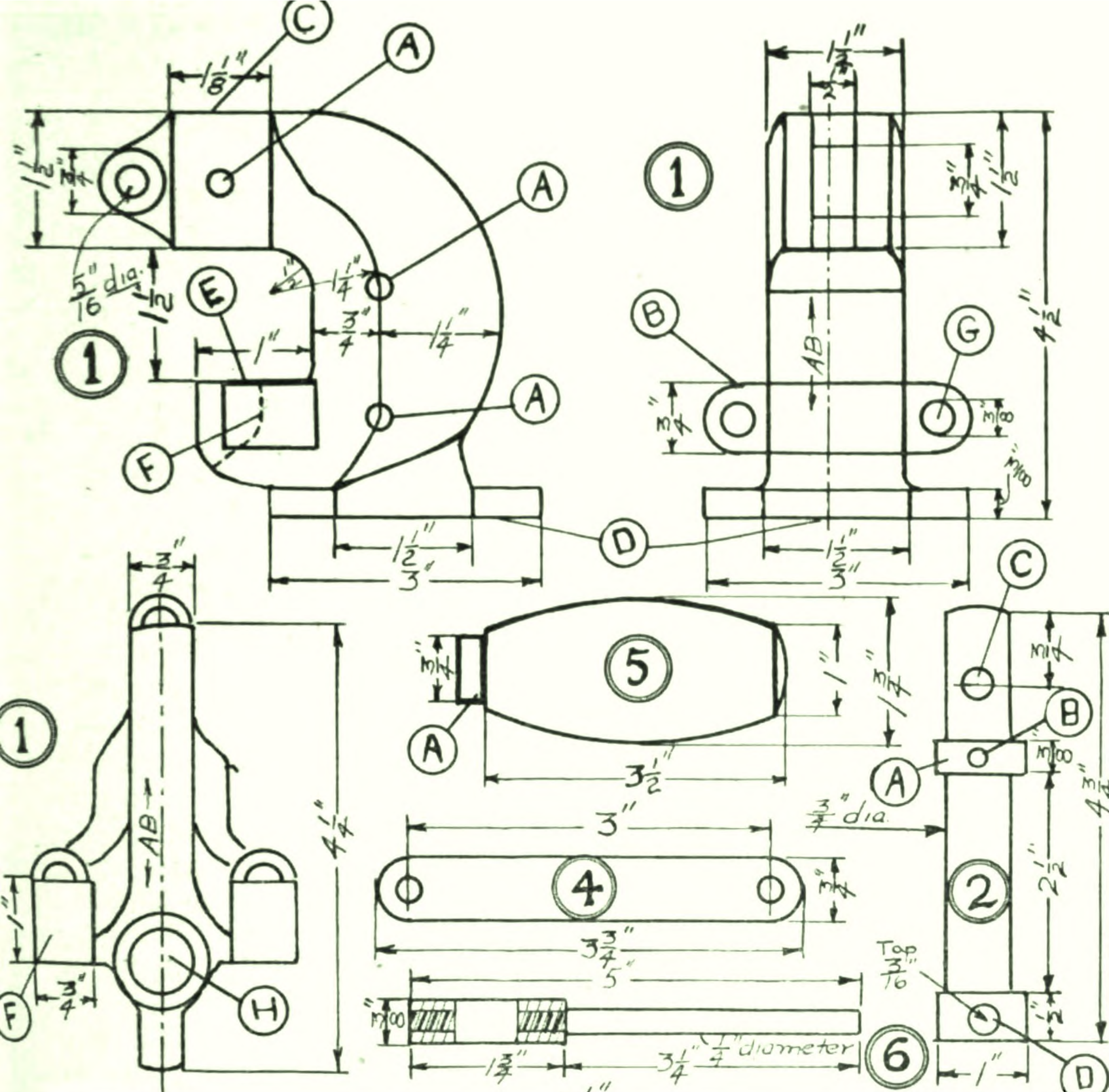

Electrician and Mechanic

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EDITED BY

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ELECTRICIAN AND MECHANIC

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ELECTRICIAN & MECHANIC

VOLUME XXVI JANUARY, 1913 NUMBER 1

QUANTITATIVE MEASUREMENT OF THE LOGARITHMIC DECREMENT

HARRY B. KIRTLAND, Captain, Ohio Signal Corps

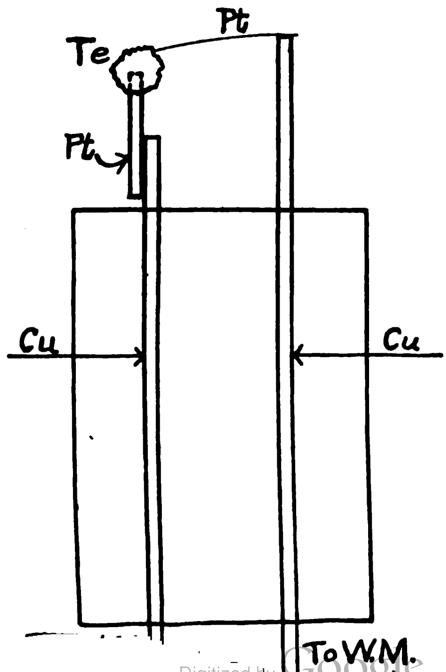
In the September number of the ELECTRICIAN AND MECHANIC, Mr. H. B. Richmond explained in non-technical terms the nature of the logarithmic decrement and the practical application of that part (4th Regulation, Sec. 4) of the latest Act to Regulate Radio-communication which prescribes a maximum limit to the decrement.

I purpose here to describe a means of ascertaining quantitatively, employing only a wave-meter and hot-wire ammeter (or galvanometer with Austin thermo-element), the logarithmic decrement of any radio-transmitter.

The method in question was worked out by First Lieutenant J. O. Mauborgne, United States Army Instructor at the Army Signal School, one of the foremost radio investigators in the world, and is in daily application in the radio work of the United States Signal Corps. It is a simplification and condensation of the elaborate and involved operations and formulae employed by Bjerknes and Fleming for the same purpose, and amply meets all requirements of the practical radio constructor, inspector or operator.

The necessary apparatus consists of a wave-meter (Pierce or other), and either (1) a hot-wire ammeter calibrated from 0 to 100 milli-amperes, or (2) a low resistance galvanometer (such as a single pivot Paul), shunted around a platinum-tellurium thermo-element (Austin) con-

about 3 mm. apart, Fig. 1. To the protruding end of one of these solder about 5 mm. of .02 mm. platinum or constantan wire. Heat a short piece (¼ in.) of No. 20 platinum wire white hot, and insert one end of it in a bead of tellurium, thus making practically a resistance free contact. Then solder the other end of this piece of No. 20 wire to the protruding end of the second copper wire.



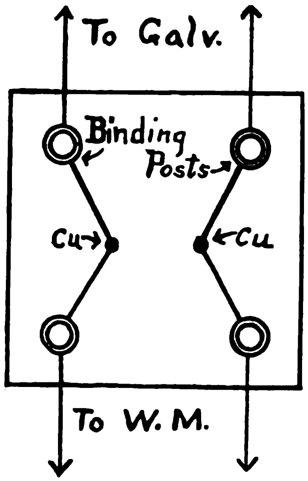


Fig. 2—Connections of Thermo-element

Allow the end of the fine (.02 mm.) wire on the one copper support to rest against the tellurium on the other, and weld the two together electrically by means of a small induction coil having a high resistance in series with the secondary. The contact will be less fragile if the welding is done in an oxygen-free atmosphere, and it will be found advisable not to undertake this welding until the element has been placed in the test-tube mentioned hereafter.

The thermo-element, thus prepared, may be put in a test tube, and the whole enclosed in a wooden box lined with cotton or felt, the hard rubber base serving as the top of the box and also as a support for four binding-posts, to each pair of which leads should be run from each copper wire of the element, as shown in Fig. 2.

Such a thermo-element will have a resistance of from 5 to 50 ohms, depending on the excellence of the welding. The lower the resistance, the better.

The function of the device is this: the galvanometer cannot respond to the high-frequency currents of the wave-meter circuit. Those currents, however, heat the platinum-tellurium junction of the thermo-element, and the thermo-electric current thereby created deflects the galvanometer, the deflections varying with the square of the current, which in turn depends on the heat produced by the high-frequency currents, and varies with their intensity. A galvanometer shunted about the thermo-element may therefore be substituted for the hot-wire ammeter.

SETTING UP THE CIRCUITS

For measurement of the damping, we must put either our hot-wire ammeter or our thermo-element with shunted galvanometer in series with the capacity and inductance of the wave-meter. Few wave-meters now in use were intended for the measurement of damping, and therefore no binding-posts for our purpose will be found on them. Other means of making the connections will have to be improvised, a matter, however, of little difficulty.

Figs. 3 and 4 illustrate the circuits with either form of indicator, the inductance and variable condenser shown in each being, of course, those of the wave-meter, and calibrated to wave-lengths in meters.

PRECAUTIONS TO BE OBSERVED

It is essential, in the measurement of damping, that the coupling between the wave-meter circuit and the circuit under measurement be constant, and that the energy supplied the primary of the transmitter be as constant as possible. Furthermore, the coupling between the wave-meter and transmitter circuits must not be too close: if it is, the damping will have too great a value. In case of doubt as to whether this coupling was loose enough, a second measurement should be made with the wave-meter farther away from the circuit measured. If a smaller value be obtained with the looser coupling, it is at once evident that the other was too close.

MEASUREMENT

(*a*) With Galvanometer and Thermo-element

Let δ_1=decrement of the damping of the circuit under measurement.

Let δ_2=decrement of the damping of the wave-meter circuit.

Setting up the wave-meter circuit, with sufficiently loose coupling, near the oscillation transformer of the transmitter to be measured, press the transmitter key. Adjusting the wave-meter until resonance is obtained, take the wave-length reading in meters, calling it λ_m, and observe the scale deflection of the galvanometer, calling this quantity D.

Now, by turning the handle of the wave-meter pointer, reduce the scale reading of the galvanometer to $\frac{D}{2}$, and take the corresponding wave-length reading of the wave-meter, calling it λ_1. Then,

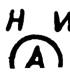
$$(\delta_1+\delta_2)=\pi\left(1-\frac{\lambda_1}{\lambda_m}\right) \text{ (where } \lambda_m \text{ is greater than } \lambda_1)$$

This gives us the sum of the decrements of (δ_1) the circuit under measurement, and of (δ_2) the wave-meter circuit itself. If the latter (δ_2) be known, it then remains only to subtract the quantity (δ_2) from the quantity ($\delta_1+\delta_2$), the result being the decrement sought.

However, the writer knows of only one wave-meter the value of whose self-damping is furnished by the makers (the Telefunken E.G.W. meter), and ordinarily it is necessary to determine this as follows:

Insert a piece of fine resistance wire (No. 36 Climax), 6 to 10 in. long, with sliding contact, in the wave-meter circuit, as shown in Fig. 5. Call decrement of this resistance wire δ^1_2.

Set the wave-meter pointer at the value of λ_m found before, and while transmitter key is depressed, move slider along resistance wire until you again get a galvanometer deflection $\frac{D}{2}$. Then, without changing position of slider, turn wave-meter pointer until scale deflection of galvanometer is equal to $\frac{D}{4}$. Read the corresponding wave-length reading of the wave-meter, calling it λ_2.



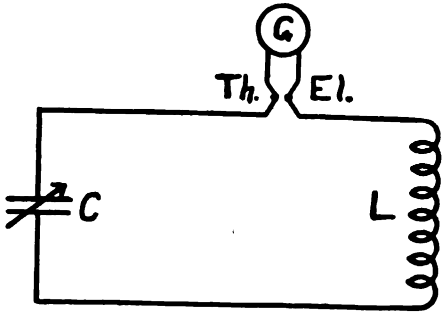


Fig. 4—Wave-meter with Thermo-element and Galvanometer in Circuit

Then,

$$(\delta_1+\delta_2+\delta^1_2)=\pi\left(1-\frac{\lambda_2}{\lambda_m}\right)$$

Let $(\delta_1+\delta_2+\delta^1_2)=X^1$
and $(\delta_1+\delta_2)=X$.
Subtracting $X^1-X=\delta^1_2$, the decrement of the resistance wire.

The decrement of the wave-meter circuit (δ_2) is then equal to $\frac{X^1\ \delta^1_2}{2X-X^1}$ which quantity, of course, is to be deducted from the quantity ($\delta_1+\delta_2$), to give us the decrement of the transmitter circuit under measurement.

(*b*) With Hot-Wire Ammeter.

Using a hot-wire ammeter instead of the galvanometer and thermo-element, the formulae are the same, but owing to the fact that the readings of the ammeter vary with the current and not, like those of the galvanometer, with the square of the current, slight changes in procedure are involved.

These are as follows:

1st.—For the initial deflection D, of the galvanometer, substitute the initial milliampere reading of the ammeter at resonance, and call this quantity I.

2d.—In each of the two instances

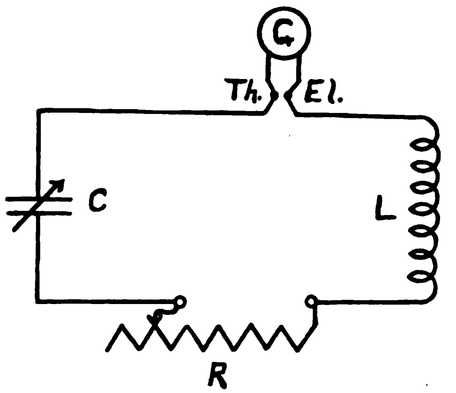


Fig. 5—Wave-meter and Thermo-element with Adjustable Resistance Wire in Circuit

the wave-meter pointer was turned until a deflection $\frac{D}{4}$ was obtained, it must now be turned until the milli-ampere reading is equal to $\frac{I}{2}$.

In all other respects the procedure with either indicating device is the same, and the formulae serve without change for both.

The methods just described are equally applicable to the measurement of the damping either of a closed oscillatory circuit containing a spark gap, or of a coupled transmitter consisting of such a circuit and an antenna circuit tuned to the same period. In the latter case, if the spark gap be of the open variety, and the coupling is close, the energy is radiated, of course, in two wave-lengths, one shorter and one longer than the wave-length to which each of the circuits was tuned. This need occasion no difficulty, if the two wave-lengths lie sufficiently far apart, for the damping of each hump may be measured separately. Where the coupling of the two circuits is very loose, or a quenched spark is employed, there will, of course, be practically only one hump, a single wave-length, radiated.

In practical work, it has been found that very sharp tuning is impracticable when a wave train contains less than 15 oscillations. This corresponds to a decrement of .2, the limit set by the statute. The experimenter will find, with most oscillation transformers, that this limit will not be exceeded if he has not more than two turns of his helix in common between his closed oscillatory and radiating circuits. If on measurement, the damping of the coupled system is found too large, inductance may be added, or the coupling be loosened, in order to decrease the resistance and hence the damping. If it be impracticable to change the wave-length, the aerial must be shortened to decrease its capacity, the same wave-length being retained by adding inductance.

Knowing the value of the damping (δ_1) of a closed oscillatory circuit, a number of other important calculations may be worked out. If its inductance in centimeters is known, or can be measured, and the high-frequency resistance R of the inductance can be calculated from the dimensions of the wire, then, knowing the frequency, N, corresponding to resonance ($N=\frac{V}{\lambda}$), one can calculate the resistance r of the spark gap from the formula

$$r=\frac{4NL\delta_1}{10^9}-R,$$

R and r being measured in ohms.

Likewise, by Fleming's rule, the approximate number of complete oscillations M in the wave train, before the amplitude of the oscillations falls to 1 per cent. of the maximum, may be found by the formula

$$M=\frac{4.605+\delta_1}{\delta_1},$$

which quantity divided by two, gives the periods.

The crews of Italian submarines have been undergoing a series of practical tests of their staying powers, says the *Engineer*. The trials were begun in July by the *Glauco*, which remained for 22 hours submerged, and this performance has now been exceeded by the *Squalo*, in Venice arsenal, with what is believed to be the record time under water of 24 hours. Her crew, composed of 20 men, including the officer in command and a navy doctor present to study the effect of the long immersion, was in absolutely normal condition when the submersible came to the surface. The experiments will be continued.

PRACTICAL REMEDIES FOR MOTOR AND GENERATOR TROUBLES

P. LE ROY FLANSBURG

Motors and generators, like all other kinds of machinery, are subject to derangements, but due to the peculiar and elusive nature of electricity, it is often quite difficult to ascertain the exact cause of the trouble. Each different kind of trouble, however, has its own peculiar characteristics by which it may be recognized, and once the trouble is located it is often quite easy to remedy it.

In this article I will consider the causes and remedies of that most common trouble, sparking.

SPARKING WITHOUT APPARENT CAUSE

Very often a machine will spark quite badly without there being any apparent cause. In such cases it is very probable that a wrong material has been used for the brushes. The manufacturers generally furnish or specify a certain kind of brush to be used with their machine, and no other kind should be substituted. The quality, shape and size of the brushes have a considerable effect on the satisfactory commutation of a motor or generator. Therefore, since the manufacturer has found by actual test the type of brush that gives the best results with his machine, his advice should be strictly followed.

SPARKING ON ADJUSTMENT OF THE BRUSHES

Sparking on adjustment or removal of the brushes may be due to one of several causes. It sometimes happens that the brush holders stick on the spindles and do not turn freely, causing the brushes to bear at only a few points. The remedy for this is to repair the brush-holder so that it may rotate freely.

Another quite common cause of sparking is a bad contact between the brushes and the commutator. This is due to the fact that the brushes are not properly ground to fit the commutator. If carbon

The sparking may also be due to the fact that the brushes are covered with oil, dirt, grease, etc. Both the brushes and the commutator should be looked over carefully, and if this is the case, thoroughly cleaned with gasoline or kerosene.

SPARKING DUE TO IMPROPER POSITION OF BRUSHES

If the brushes are in a wrong position, it can easily be detected, for the amount of sparking will change as the brushes are moved backward or forward. The brush-rocker may be in the wrong position or the relative position of the brushes may be wrong. If the latter is the case, moving the rocker will stop the sparking at some of the brushes and cause it to begin at others which formerly did not spark. The brush-rocker should be first rocked backward and forward slowly until there is a minimum of sparking. If the sparking continues, make sure that there is an equal distance between the brushes, by counting the commutator bars between each brush. In a two-pole machine the brushes should be exactly opposite; in a four-pole machine, 90 degrees apart; in a six-pole machine, 60 degrees apart, etc.

SPARKING DUE TO IMPROPER COMMUTATOR MATERIAL

The quality and material of the commutator will often be found to be the cause of the sparking, when no other cause can be found. Carbon brushes work satisfactorily only on copper commutators, and if the latter is made of bronze or gun-metal, as is sometimes the case, trouble is bound to ensue. The quality of the copper in the commutator may vary with the depth, and as the commutator wears down, trouble begins. The only possible thi-

armature or any single armature coil may show no excessive heating, but if current is sent through the armature while it is being slowly rotated, sparking will again occur. To remedy this, the screws fastening the bar and conductor should be tightened, or conductors should be resoldered. If it is found that the break occurs in one of the coils, the only remedy is to rewind the armature.

SPARKING WITH LOW ARMATURE VOLTAGE

On first starting a multi-polar machine, one or more sets of brushes may spark heavily, while the armature voltage is low, although the speed and field current are normal. This is due to one of the field coils being connected in the reverse direction, so that it opposes the other field coils. It is an easy matter to locate the faulty coil by following the direction of the windings. The coils should be connected alternately clockwise and counterclockwise, so that the consecutive fields produced are in opposite directions. A compass may also be used to determine whether this condition is obtained. When the coil is located, the end connections should be reversed.

SPARKING WITH ONE FIELD COIL UNDULY HOT

Sometimes one or more sets of brushes spark heavily as before, but one of the field coils is unduly hot while the others are colder than usual. This may mean that a portion of one of the field coils is short-circuited so that the pole does not become excited. Dampness in the coils may produce this short-circuit, and therefore great care should be taken always to have the coils dry. Another possible cause is the short-circuiting of the wires joining the field coils. The coils should then be rewound or the connecting wires insulated.

SPARKING MORE APPARENT AT CERTAIN SPEEDS

Sparking may occur only occasionally and be more apparent at certain speeds. This is due to the vibration of the machine, which may occur at all speeds or only at certain critical speeds and which depends on the unbalanced condition of the armature or pulley. The pulley should be removed and "turned" true. If it were the pulley that was at fault the trouble would then disappear, but if the armature were at fault it would be necessary to balance it by adding a small weight to one of its sides. This weight might be either a small amount of lead or babbitt poured into slots provided for just such purposes on the inside of the armature flange. If these slots were not provided, the weight might be bolted to the inside of the armature. The weight added must be so adjusted that if the armature is mounted on knife edges it will not rotate of its own accord.

SPARKING WITH INCREASE OF LOAD

When the load on a dynamo is increased, sparking will frequently occur. This shows that the machine may be running at too high a speed. The machine should therefore never be run at a speed higher than its rated speed. When the machine is running at an abnormally high speed, the shunt field current has to be decreased in order to keep the same voltage. This is because with an increased load, the armature current increases, and the armature reaction is increased, weakening the field. The field due to the armature finally reaches a point where it nearly overcomes the field due to the poles and sparking occurs. Overload may produce sparking even in a perfect machine, and the remedy is to reduce the load as soon as possible.

SPARKING DUE TO A ROUGH COMMUTATOR

Sparking may occur and the brushes vibrate slightly while the commutator is apparently smooth. This comes from the fact that the mica insulation between the commutator-bars is slightly harder than is the copper, and therefore does not wear out as rapidly. The remedy for this is to turn down the commutator, or to file down the mica alone, with a triangular file.

SPARKING DUE TO ARMATURE OUT OF CENTER

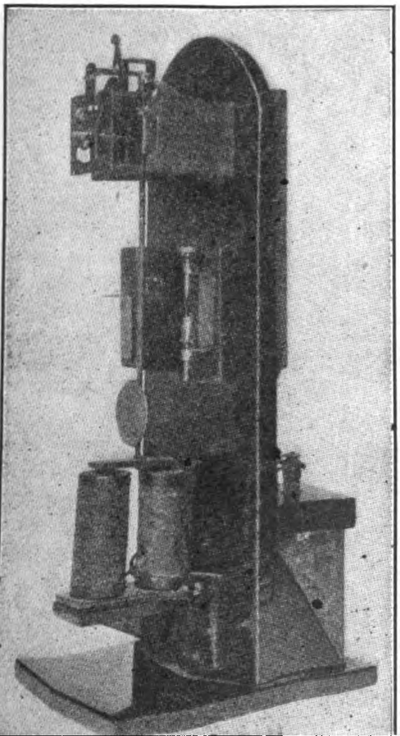
If the armature is not properly centered the air gap will not be of uniform width at all points between the armature and the pole faces. Such a condition is liable to occur, especially in large machines, as the bearings become worn with use, and unless some method is employed

(*Concluded on page* 18)

AN ELECTRIC CLOCK AND HOW IT WAS MADE

F. COLLIER FLETCHER

The clock just completed by the writer, and herewith illustrated, is a purely electrical timepiece, as it is not dependent on another clock for its motion. It is self-contained, the batteries being placed as shown in Fig. 1, so that the whole can go under a glass shade and stand on a bracket or mantelshelf; an excellent timekeeper as well as an electrical novelty. From an examination of the photographs and sketches, it will be seen that there is a pendulum which has a soft-iron armature at its lower end, swinging over an electromagnet, which gives impulses to the pendulum as required. About the center of the rod is the contact-maker, a V-shaped piece of steel pivoted at the top. As the pendulum swings this piece catches the notched piece fastened upon the spring, but as long as the pendulum has a good swing it rides over the notch, but when the swing gets short the bottom of the V-piece catches in the notch and pushes



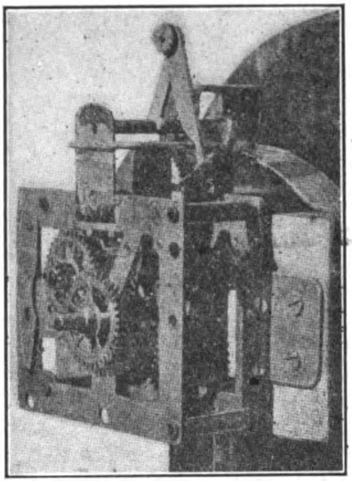


Fig. 2—Clock Mechanism

it down, and the end of the spring—which has a short piece of silver wire affixed—is depressed into the mercury cup shown on the right-hand side of the photograph, Fig. 1. This makes electrical contact, actuating the magnets, and gives another impulse to the pendulum, which swings a number of times from its own momentum before contact is again required.

Fixed at the top of the pendulum-rod is the ratchet-lever driving the works. This lever is so arranged that, no matter what the swing of the pendulum may be, it pushes one tooth of the ratchet-wheel each second. As the length of pendulum regulates the time-keeping, the armature is made adjustable, and the magnets form a sliding bracket to adjust to the armature. The works are adapted from an ordinary cheap, circular alarm clock, with the balance arrangement and the alarm works taken out. Now that the principle of the working of the clock has been described, the construction can be considered.

The pendulum-rod is a piece of $\frac{3}{16}$ in. round brass rod, 11 in. long, the bottom end threaded for 1 in. A circular disc of sheet brass, 2 in. in diameter is soldered to the rod, the center bein[illegible]
the bottom

from the bottom of the rod. The V-piece is of steel ½ x ¼ in., filed nicely to shape and drilled an easy fit for the steel pin. Two small collars of brass are soldered on the pin as shown, Fig. 8. The V-piece must have no play, yet swing freely. Next obtain a piece of soft-iron for the armature, 2¾ x ¾ x 3/16 in., bore a hole in center, and tap same to screw on bottom of pendulum-rod. A 3/16 in. nut is also required to lock the armature on rod. Slightly flatten out the top end of the pendulum-rod by hammering, and bore a 5/32 in. hole for the pivot. The magnet bobbins are turned out of some hard wood to the dimensions given (Fig. 9) and bored 7/16 in. Wind the bobbins with No. 22 covered wire, about 4 or 5 oz. on each. Connect them so that one has a north and the other a south pole. If cotton-covered wire is used, cover the bobbins with green silk, first pasted on paper for appearance. The magnet cores are of 7/16 in. soft iron and are driven a tight fit into the soft-iron base, 3½ x 1 7/16 x 3/16 in. Two holes for wooden screws are drilled as shown in Fig. 10. The centers of the cores must be about 2 in. apart. The sliding bracket carrying the magnets needs no comment and need not be made accurately to size. Four wooden screws in the runners tighten up the bracket when it is adjusted.

The contact arrangement should now be taken in hand. The part *A*, Fig. 7, is strip brass, the top portion being bent over at right angles ¾ in., as shown. A piece of watch spring 5½ in. long is soldered to *A*. Underneath the other end of the spring, solder ½ in. of silver wire. From a semi-circular piece of brass ¼ in. wide and as deep as the spring, file a notch as *C*, Fig. 7, to catch the V-piece on pendulum-rod. The part *B*, Fig. 7, is also made from strip brass tapped 3/16 in. top and bottom, and with a screw at top and lock nut. The bottom end of this screw is drilled, and a peg of vulcanite is inserted to insulate it from the spring. The little mercury cup is made from a cycle lubricator with a 3/16 in. screw and lock nut *B*, Fig. 7. Next obtain a circular tin-cased alarm clock. It will be noticed on removing the case that the wheel next to the escape wheel has 60 teeth and revolves once a minute. Get a wheel made the same size, but with 60 ratchet teeth, and fit to the spindle in place of the other wheel. In the writer's clock this wheel was 1⅛ in. in diameter. The balance springs and alarm works can be removed, as they will not be required again.

From some strip steel ⅝ in. wide by 1/16 in. thick, make the bearings for the pendulum pivot, one being shown in

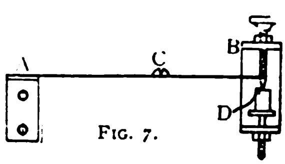


FIG. 7.

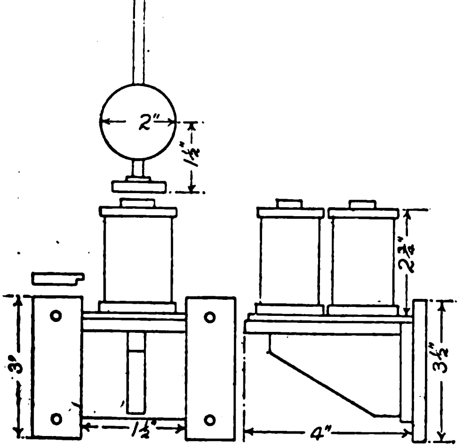


FIG. 6.

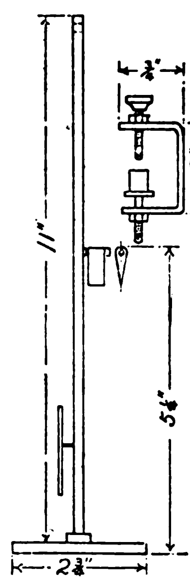


FIG. 8.

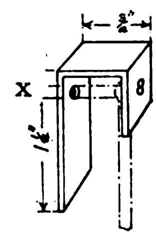


FIG. 3.

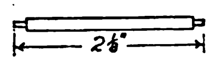


FIG. 4.

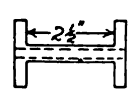


FIG. 9

Details of the Electric Clock

Fig. 3; the front one being as shown in the photograph, Fig. 2. The hole *X*, Fig. 3, is larger than the pivot, so that it will not touch there. Solder the bearings to the front and back of works, as shown in Fig. 2. The pivot of steel rod 5/32 in. in diameter is shown in Fig. 4, and the ends are reduced to about 3/32 in. They must be a nice easy fit. To make the ratchet-lever, file a strip of brass to dimensions of *C*, Fig. 5, and solder to pivot as shown. At the top, pivot the piece *D* on a steel pin, so that it hangs freely, but without side play. Solder a length of fine watch-spring to a convenient part of the work, to bear against the ratchet-wheel *H*, Fig. 5, and prevent it from slipping backwards. Obtain a 2 in. length of darning needle or cycle spoke, and solder to the front bearing, as shown in Fig. 2. Before doing this, however, it would be advisable to fit the other parts together on the woodwork, as this ratchet-lever is rather difficult to adjust correctly.

The base is a piece of mahogany 7 x 8½ x ½ in. thick, and the upright is a similar piece, 18 x 6½ in., screwed to the base, and with angles pieces of wood to support the upright as shown in the photograph, Fig. 1. As the back plate of works has to be 2½ in. in front of the upright, screw blocks of wood to same and solder a piece of brass on each side of the works. Blocks of 1 x 1 in. mahogany go behind each side of the contact breaker to bring it the correct distance from the upright. Fit the parts together. Solder the top of pendulum rod to pivot and put the wheels in the works. Screw works to the blocks of wood and these blocks to the upright. Fix the magnets underneath armature centrally and screw the contact breaker in position with the spring horizontal, and fill the cup with mercury. The V-piece on pendulum rod comes over the spring; the bottom of V should be ⅛ in. below the notch in *C*, Fig. 7, and this notched piece should be soldere[d]

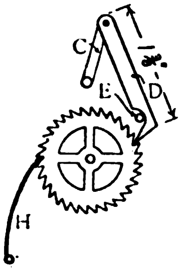


FIG. 5.

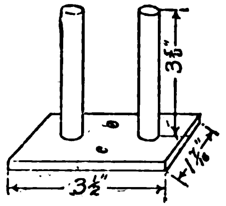


FIG. 10.

center of the notch, the V drops in same and contact is made.

The wire *E*, Fig. 5, must be so adjusted to the curve in lever *D* that it only pushes one tooth of the ratchet-wheel, no matter what the swing of the pendulum is. The curve in *D* will have to be carefully filed to ensure a correct position, and the spring *H*, Fig. 5, adjusted to suit *D*.

The batteries can be two Leclanché cells; the writer uses Empire cells joined in series. The wiring is as follows: One wire from the magnets goes to a terminal of the battery, the other wire goes to the mercury cup. The opposite side of the contact breaker *A*, Fig. 7, is connected to the other terminal of the battery. It will make a neat job if the wires are all carried behind the woodwork out of sight. To minimize sparking in the mercury cup, a condenser should be made, consisting of about 56 sheets of tin-foil 5 x 4 in., interleaved with paraffin paper, as on a spark coil. The ends are joined one to each side of the contact breaker. In the photograph, Fig. 1, the condenser will be seen fitted in a narrow wooden box and screwed to the back of the upright above the batteries. The dial arrangement is the only part now required to complete the clock, and a celluloid dial should be purchased from some wholesale jeweler. It is glued in place of the old one. A glass bezel should also be purchased. Turn a mahogany ring, as shown in the photograph, to fit friction-tight and come flush with

LACQUERING

V. W. DELVES BROUGHTON

I believe most amateurs have experienced the same difficulties in lacquering their work, that I have, so I make no apology for giving the following hints, says Mr. Broughton in *The Model Engineer and Electrician.*

To lacquer a plain cylindrical object, chuck the same in the lathe, and after thoroughly polishing, finish off with a clean rag covered with whitening, running the lathe at a high speed and using considerable pressure. It will generally be found that sufficient heat has been developed by this process; if not, the article must be warmed by a spirit lamp or Bunsen burner till it is as hot as can be comfortably borne by the back of the hand. The article is then quickly dusted with a clean cloth, and the lacquer applied with a pad, much like French polishing, but taking care to go only once over the object with a light but firm touch. In a similar manner large flat surfaces can be treated.

Small and irregular-shaped pieces can be treated in the following manner: First, they are finished and polished or dipped in acid; then they are dipped in caustic potash (American potash will do equally well), about a 10 per cent. solution, which is better used hot if there is any fear of contamination with grease; then quickly rinsed in clean water and dipped into the following bath, which must be kept nearly, but not quite, at the boiling point. Take 1½ oz. of best Scotch glue, and soak the same in 5 pt. of water till quite soft; then melt over the fire and add 1 oz. of bichromate of potash. Just before dipping, the scum on the surface should be removed with a piece of card. The articles must be left in the bath for a sufficient time for them to become heated to the temperature of the bath, so that when removed they will dry almost instantaneously. The articles are next exposed to sunlight for about an hour, when it will be found that the film of bichromated glue left on the surface has been rendered perfectly insoluble. The protection of metallic surfaces in this manner is very thorough, and, thin as the protecting film appears, it offers a wonderful resistance to atmospheric influences.

If the articles to be lacquered are polished aluminum, or alloys of that metal, the caustic potash bath must be omitted, and the articles brushed with fine powdered bicarbonate of soda just sufficiently moistened to stick to the brush. Caustic potash will give aluminum a frosted appearance, especially if used hot.

This manner of protecting metallic surfaces has the advantage that it scarcely shows at all; and if good gelatine is used instead of glue the film would be still more imperceptible. For white metals, chrome alum might be substituted for the bichromate, and ¼ oz. instead of 1 oz. used to the same quantity of glue or gelatine and water. Placing in the sun would then be unnecessary, as chrome alum has the power of rendering most coloids insoluble without the agency of light. I mention this last recipe more as a suggestion than as a proved process, for, although I have used it, I have not kept by me the articles that have been treated in this manner for a sufficient length of time to test its resistance to the atmosphere.

All lacquering should be done in daylight, as it is nearly impossible to see if it is laid on properly by artificial light, and work that looks perfect by gaslight will appear a mass of smears in the day time.

If deep colors are admired, the following may be added to the lacquer employed (but it should be noted that the deeper the color the more difficult it is to lay on the color evenly)—Bismark brown, a deep copper color; dragon's blood, a fine deep golden color; turmeric and gamboge, both of which give a good light golden color. Saffron gives a good color to the liquid used in the glue-bichromate process, and may be used alone or with a mixture of tincture of logwood. The glue-bichromate solution may be kept for a long time if bottled, but should be filtered through two or three thicknesses of good flannel before use. I do not know whether the addition of coloring matters would affect its keeping qualities; it is cheap enough, however, and there is very little expense or trouble in making up a new bath when required.

A METHOD OF CALCULATING DIFFERENTIAL INDEXING

STEPHEN HOUSE

The mathematics of the universal milling machine are interesting in the extreme, and to the enquirer the method of differential indexing is one which compels attention. Plain indexing is simple enough; compound indexing is ingenious, but is not so handy as the differential. Compound indexing lends itself more to error than does the differential, as it is not so easy to keep the direction of two separate calculations and movements in mind as it is to remember that the crank moves in only one direction. The only difference between plain and differential indexing is the admission of some easy gearing into the latter case; the principle of indexing and the movement of the crank is precisely the same in each case. How to arrange for the necessary gearing for the differential without reference to the tables which Brown & Sharp issue with their machines or in the absence of any such assistance is what every operator of a milling machine ought to know.

Differential indexing is the sum or difference of fractions to give the required advance of the crank for one division on the piece milled. In this it resembles compound indexing. There is this difference, however: whereas in compound indexing the machinist must attend to both crank and plate movement, in the differential indexing the crank only demands his attention, the plate being moved backwards or forwards by the gears used.

Suppose for instance that we wish to cut 51 teeth. No index plate usually found in the shop will enable us to do this by direct indexings, as we would require a 40-hole move on an index circle of 51 holes. That is, the crank would move $\frac{40}{51}$ of the circumference of the plate for every division cut. As this is an impractical fraction by direct indexing let us get as near as we can by this method: $\frac{42}{51}$ is very near to $\frac{40}{51}$, and can be obtained by taking 14 holes on a 17-hole index circle, since $\frac{42}{51}$ is the same as $\frac{14}{17}$. But, if we adopt this fraction we are $\frac{2}{51}$ in excess of what we need. Hence it will be at once seen that we must arrange the gears in such a way as to counteract and cancel this excess. This can be done by causing the index plate to move backwards $\frac{2}{51}$, whilst the crank moves forward $\frac{42}{51}$, or $\frac{14}{17}$ of the index circle. $\frac{2}{51}$ movement negatively of the plate per one division of 51 is manifestly 2 whole turns by the time we have gone the 51 divisions. That is to say, while the spindle has made one complete revolution (=51 divisions made) the index plate has made two complete revolutions, and this would only be effected by using gears on the spindle and worm in the ratio of 2 : 1. Those recommended by Brown & Sharp in their tables are 24 on the worm and 48 on the spindle. 28 and 56 would do just as well, or any other convenient two, so long as the ratio spindle : worm : : 2 : 1, holds good.

All gearing, however, does not work out so simply as this, and it is sometimes necessary to try both a positive and a negative movement of the plate before deciding which to adopt. This is well illustrated in the case of a 99 gear. Direct indexing demands a 99 circle with the sector set for a 40-hole move. This is impractical, but $\frac{40}{98}$ is near to $\frac{40}{99}$, and $\frac{40}{98}$ is obtained by 20 holes on the 49 circle. We want 99 teeth, however; not 98 teeth. So we must arrange for an extra tooth. Hence, the index plate must move in the direction opposite to that of the crank, and the amount of negative rotation per 1 tooth cut is plainly the difference between $\frac{40}{98}$ and $\frac{40}{99}$; $\frac{40}{98}-\frac{40}{99}=\frac{3960-3920}{9702}=\frac{40}{9702}$. Therefore the total negative movement of the plate by the time the 99 teeth are cut $=\frac{40}{9702} \times 99 = \frac{40}{98}$; that is, whilst the spindle has made one complete revolution the index plate has made $\frac{40}{98}$ of a complete revolution in a direction opposite to that of the crank, or, working in whole numbers, if the spindle were to make 98 revolutions, the index plate would make 40 only. Gear

on spindle to gear on worm, must then be in the inverse ratio of their relative movements, that is, 40 : 98. 40 : 98 = 1 : 2.45, and there are no gears in common use which give this ratio exactly, though 40 on the spindle and 100 on the worm give a close result, yet not near enough. Apparently, then, all our working is for nothing. Let us try the other tack, however, and instead of $\frac{40}{98}$, let us try what $\frac{40}{100}$ will do. 100 teeth being 1 too many, we shall have to cause a rotation of the index circle in the direction the same as the crank. The amount of movement is obtained as before: $\frac{40}{99} - \frac{40}{100} = \frac{40}{9900}$ per 1 tooth: $= \frac{40}{100}$ per 99 teeth : $= \frac{40}{100}$ of 1 turn for one complete revolution of the spindle. Hence, gear on spindle : gear on worm = 40 : 100.

That is, a 40-gear on spindle : 100 on worm. Here is a case where simple gearing will not do. We must resort to compound gearing, remembering always this rule. The product of gear on spindle and first gear on stud to product of second gear on stud and gear on worm must be equal to the required ratio. In this case, 40 : 100 = 2 : 5.

The usual gears are 24, 28, 32, 40, 44, 48, 56, 64, 72, 86, 100, and we must investigate to find two pairs such that the quotient of their respective products equals $\frac{2}{5}$. This step may need a little time, but is not impossible, as is shown thus: $\frac{28 \times 32}{40 \times 56} = \frac{2}{5}$. Consequently, we immediately set our gearing 28 on spindle and 32 as first gear on stud; 40 as second gear on stud with 56 on the worm.

As another illustration let us take 125 teeth, which by direct indexing would require $\frac{40}{125} = \frac{8}{25}$. No index plate will give this fraction, but we can obtain $\frac{9}{27}$ or $\frac{13}{39}$, or $\frac{7}{21}$, on index circles, and these fractions are very close to $\frac{8}{25}$. As a matter of fact, they are slightly larger, so that the plate must be given a negative movement.

Proceeding as before: $\frac{9}{27} - \frac{8}{25} = \frac{1}{3} - \frac{8}{25} = \frac{25-24}{75} = \frac{1}{75}$.

That is, the index plate must move negatively $\frac{1}{75}$ of a revolution per 1 tooth, which is $\frac{125}{75}$ of a revolution per 1 revolution of the spindle, or $\frac{5}{3}$ of a revolution per 1 revolution of the spindle.

$\therefore$ Gear on spindle : gear on worm = 5 : 3.

40 on spindle and 24 on worm satisfies this condition.

It will be noticed that when the denominator of the fraction adopted is greater than the denominator of the true fraction, it is necessary in order to correct the difference to advance the index plate in the same direction as the movement of the crank. For instance, $\frac{40}{99}$ is greater than $\frac{40}{100}$, and, since the latter fraction is the one we adopted, it plainly becomes the work of the index plate to make up the difference, to give 99 teeth instead of 100. Every time the index plate moves forward it increases the fraction represented by the movement of the crank alone, and *vice versa*, when it moves backwards (that is, in a direction opposite to that of the crank) it decreases the fraction represented by the crank movement. The larger the fraction of a revolution that the spindle makes per tooth, the fewer the teeth, and contrawise. Hence, if our adopted fraction as, for instance, $\frac{42}{51}$ represents less teeth than we require, the index plate must equalize matters by moving backwards. So that it is only necessary to remember whether the fraction is greater or less than the true one to determine whether our index plate is to make a forward or backward movement, relative to the movement of the crank. A forward movement is obtained by the use of one idler, a backward movement by the use of two idlers. Two gears on a stud are the same as one idler in their effect.

By this method of fractions gears may be determined for any number of divisions up to or beyond the 382 which ends Brown & Sharp's tables. It takes a little time, perhaps, but when one has done a few examples in this manner, he is able to decide almost intuitively what fraction to adopt. By one movement or the other, forwards or backwards, this method gives correct results.

PRIZE CONTEST

ENTRY NO. 1

AN ASTATIC GALVANOMETER

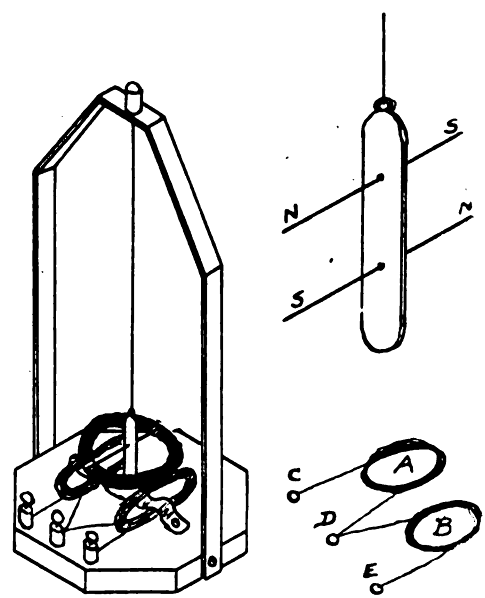
LEONARD MORAN

The Astatic galvanometer is a very sensitive instrument, and so it is a great help in a wireless station. It consists of two magnetic needles, two coils of wire, three binding-posts, hardwood base, strip of copper or brass (never tin or iron) to form a bridge, and a cork. All tacks and screws are of brass.

Each coil is made separately of 10 ft. of No. 30 insulated copper wire, wound about the base of a drinking glass, to give it its shape, and then pressed into an elliptical shape, and fastened to the base block with a brass or copper strip, held down with small brass screws.

The base-block should be 4 in. square. First cut off the corners of the base block, and then give it several coats of shellac. The bridge is made from brass 1/16 in. thick, 1 in. wide and 7 in. long, which is screwed to the outside of the block, as shown in the illustration. A small hole is drilled through the top of the bridge to admit a cork and screw-eye. Ordinary large compass needles may be used or magnetized pieces of highly tempered steel piano wire will do. A short piece of wood can act as the carrier-bar for the needles. When the needles are arranged properly, suspend them from the screw-eye, fastened in the cork, by a thread. A circular indicator disc of cardboard is marked and attached to the top of the coils with a few drops of wax.

Three binding-posts are now placed on the base block and to them the end wires of the coils are attached as shown by the illustration. When making connections for a strong current, attach one of the leads to the middle binding-post and the other lead to one of the outer binding-posts. For a weak current, attaken in wiring the instrument. As the needles and coils are very sensitive, it is best to cover the entire apparatus with an inverted glass jar. A bluestone or gravity battery jar will serve very well for this purpose.



An Astatic Galvanometer

[The article by Mr. Moran is one of the articles submitted in our Prize Competition. The winner of this Competition will receive a prize of $10.00, and articles which do not win the prize, but which are of sufficient practical value, will be purchased by us at our regular space rates. Let us hear from some of our other readers who can tell "How to Build" experimental ... The Prize Com-

WIRELESS TELEGRAPH AUXILIARY SETS FOR STEAMERS

LEO F. WHITEHEAD

The new "wireless" law, which went in effect October 1st, requires all ships having wireless apparatus to carry two operators, one of whom shall be on duty at all times when the ship is under way. This law applies to all ships that came under the previous act requiring that they be equipped with wireless apparatus. Concurrently there is an enactment making it necessary for all such ships to have an auxiliary power capable of transmitting signals a distance of 100 miles over sea under all conditions. This power is to be used in case of emergency, and to operate independent of the ships' ordinary power supply.

The Marconi Wireless Company uses the storage battery almost entirely as a means of obtaining this power. The entire wireless equipment is so extensive that the reader can readily see to what enormous expense the wireless and steamship companies are under to provide for the safety and comfort of the people who travel by water. If anything should happen to the ships' electric generators—and in the past it has been customary to depend upon them—the wireless set is thereby put out of commission; and if generator troubles occur on land, there is still greater opportunity for them at sea. At sea, the ship's power is one of the first things to go "dead," particularly if water gets in between decks. The storage battery is installed in the wireless room, which in most cases is on the top deck, therefore the last place where water would reach it. The sort of battery being installed at the present time is the lead type, which has a capacity of at least from 40 to 60 ampere-hours. There is a switchboard with the necessary apparatus for controlling the charge and discharge. This size of battery is sufficient to operate a 10-in. spark coil specially used with this set. One end of the spark gap is connected with the deck [illegible] Only one key is required, for a double-hole double-throw switch is used to throw the large or the small set in operation. The storage batteries are charged from the ship's electric light mains. The line voltage ranges from 110 to 220, and in some cases is even higher. This makes it necessary to charge the batteries through a limiting resistance, the amount of which is made to correspond with the ship's installation and thereby adjusts the rate at which the batteries are charged. A voltmeter is used to show the condition of the batteries. An underload relay is in series with the batteries. It has a disc attachment which makes and breaks the circuit. The batteries cannot be charged until the disc makes a contact. The aerial switch closes the key circuit. This is the means of safeguarding the receiving set.

Intermarriage in China

President Yuan Shih Kai has issued a "mandate" enjoining on the five races who compose the population of the republic the desirability of intermarrying, to the end that in time they may become welded into a single people.

"As the present form of government," says the document, "is based upon the union of the five families for the formation of a new nation, it is essential that territorial distinction should be entirely eliminated and mutual good feeling should be daily enhanced. According to the rules of old, prohibitions existed as regards intermarriages between Chinese and Manchus, as well as between Chinese and Mongolians; and there have also been few marriages of the two families of the Moslems and Tibetans with that of the Chinese.

"During recent years proposals to abolish these old prohibitions, with a view to assimilating their customs and [illegible]

NOTES ON WIRE AND METAL GAUGES

GEO. GENTRY

The following hints have been put together not necessarily in any concise form or as an exhaustive reference (for the latter, see any good tool-dealers' catalog), but as they have occurred to the writer in some few years of light workshop experience. The master hint of all is to use your tools fairly and within reasonable limits for the purpose for which they are intended. For instance, don't take the shank of your 1-1000 in. micrometer to drive in a tack; even if you have mislaid your tack hammer and cannot wait to find it; it will be cheaper to go out and buy another hammer.

WIRE AND SHEET GAUGES

It is suggested that the writer commence with some notes respecting wire and plate gauges, and as so much remains to be learned as to the proper use of the different gauge plates sold, no doubt a few hints will be useful.

There are some two dozen different standards for gauging wire, sheet metal and drills in constant use in America, England and the Continent. The following are those which can be referred to as representative and most useful for the workshop.

The Imperial Standard Wire Gauge has limits from seven 0's (.5 in.) to one 0 (.324 in.), and No. 1 (.300 in.) to No. 50 (.001 in.)—57 sizes in all—and is the only legal standard for wire of all metals in England. The Board of Trade fixed these equivalents in 1884. All engineering tables and most trade catalogs give accurately the equivalents. The usual forms of gauge are the folding round notch gauge, Fig. 1, the folding oval notch gauge, and oblong notch gauge. The first-named is the most compact and handy form, especially when put up in a leather case. The usual limits are either from 1 to 26 inclusive, or 1 to 36. Twenty-six sizes are quite sufficient for ordinary use. It should be noted that I.S.W.G. gauges are always of notch form, as this form is more convenient for calipering a strand of wire selected from a hank and also for gauging a sheet of metal. This gauge is sometimes known as the standard wire gauge, and abbreviated

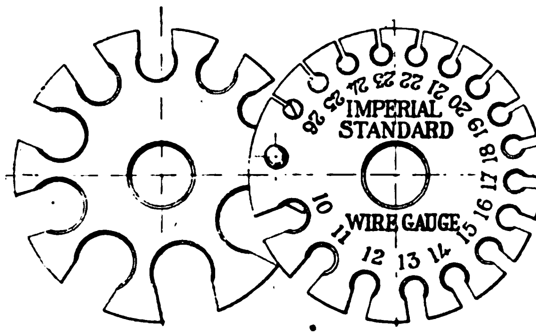


Fig. 1—Folding I. S. Gauge—(Full Size)

S.W.G. Note that the most useful numbers to remember are No. 3=¼ in. 2-1000ths full; No. 6=3-16 in. 4½-1,000ths full; No. 10=⅛ in. 3-1000ths full; No. 16=1-16 in. 1½-1000ths full, and No. 21=1-32 full.

The Birmingham Wire Gauge is identical with that known as Stubb's Iron Wire Gauge, and was the general gauge used before the introduction of the I.S.W.G. Care should be taken in buying second-hand or using old-gauge plates—usually oblong patterns—that (unless you particularly need B.W.G. sizes) the notches are not those sizes, for, although Nos. 1, 15, 21, 22, 24 and 26 are alike in both, other sizes give as great a difference as .011 in. For reference as to equivalents, see Pfeilschmidt's "Wire and Sheet Gauges of the World."

Perhaps one of the most useful ideas respecting gauges for wire or plate ever devised is that of the Whitworth decimal gauge in which the designating numbers correspond to the thousandths of an inch. No. 1=.001, No. 2=.002, and so on. No table equivalents are necessary, as the number designates the size. This gauge is very little used among wire manufacturers on account of its range, there being, as a matter of course, 250 sizes up to ¼ in. No gauge plates are sold to W.D.G. sizes, as the micrometer is better adapted for testing these.

Stubb's Steel Wire Gauge, also known as Lancashire Pinion Wire Gauge, was many years ago introduced by Messrs. Peter Stubbs, Ltd., Warrington, and the most reliable gauge plates sold now

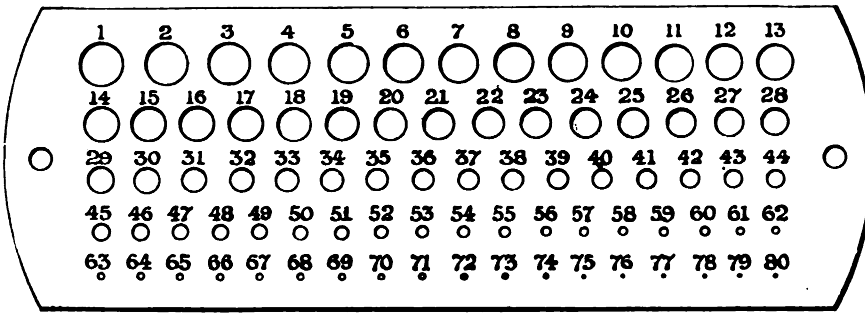


Fig. 2—Stubb's Gauge Plate—(Full Size)

bear the name of that firm. The limits are from H1=.494 to A1=.420, from Z=.413 to A=.234, and from No. 1=.227 to No. 80=.013—114 sizes in all. The usual form of gauge plate has holes and not notches. See Fig. 2 (an illustration of the number sizes only). It is used for gauging short lengths of crucible cast steel (more generally known as silver steel), which is rolled bright and used for the purpose of making tools, such as taps, drills, reamers, etc., and for spindles in light machinery. It is also used for gauging broaches.

What are known as standard English taper broaches are gauged to Stubb's sizes at the shoulder or maximum diameter, and the numbers of such correspond to the same. There are also on the market twist reamers made to these equivalents. It should be carefully noted that although tool manufacturers state in their lists that twist drills are made to Stubb's gauge, this is only applicable to the letter sizes, A to Z. For some reason unknown to the writer, the present practice of the Morse Twist Drill & Machine Tool Co. and nearly all makers of wire twist drills is to vary the number sizes in relation to Stubb's gauge, the average variation being about .001 of an inch. For reference as to Stubb's equivalent, see "Pfeilschmidt" for complete range. The expression "Steel Wire Gauge" in reference to Stubb's gauge is applied in relation to the gauging of finished tool steel in short lengths, the range of sizes and the whole form of gauges being most suitable.

The I.S.W.G. is also used for steel wire in the hank, but the greater jump from one size to another renders it less useful for gauging tool steel, as it would necessitate more turning for intermediate sizes than is the case with the finer gradations in Stubb's gauge. A table is appended, giving the most suitable sizes of bright silver steel wire for making Whitworth and B.A. taps and screws, the numbers referring to Stubb's gauge. A copy of this should be useful in the workshop.

TABLE OF STUBB'S STEEL WIRE GAUGE
Equivalent to Whitworth and B.A. Screws

Whitworth

Size	Stubb's No.	Error
1-16 in.	52	.0005 full
5-64 in.	46	.00087 full
3-32 in.	41	.00125 full
7-64 in.	34	.00062 full
1-8 in.	30	.002 full
9-64 in.	27	.00237 full
5-32 in.	21	.00075 full
11-64 in.	17	.00012 full
3-16 in.	11	.0005 full
13-64 in.	5	.00087 full
7-32 in.	2	.00025 full
15-64 in.	A	.00038 bare
1-4 in.	E	None
17-64 in.	H	.00037 full
9-32 in.	K	.00025 bare
5-16 in.	O	.0035 full
3-8 in.	V	.002 full

British Association

No.	Stubb's No.	Error
16	67	None
15	64	None
14	60	None
13	55	.003 full
12	55	.001 bare
11	53	.001 bare
10	50	.002 full
9	48	None
8	43	.002 full
7	39	.001 full
6	34	None
5	30	.001 full
4	27	.001 full
3	20	None
2	12	None
1	3	.003 full
0	B	.002 full

The Metal Gauge, or Birmingham Metal Gauge (abbreviated B.M.G.), has a useful range of sizes for gauging metal

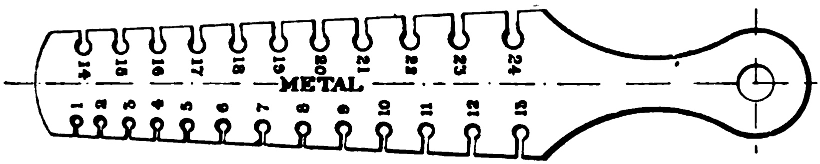


Fig. 3—"Magna Charta" Metal Gauge—(Two-thirds full size)

sheets, and is used principally by artists in metal work and also by workers in the precious metals. It is sometimes called the "Shakespeare gauge" by jewelers and silversmiths, on account of the fact that Messrs. Shakespeare & Sons, of Birmingham, supply gauge plates principally to the jewelry trade. The usual form of gauge is notched as shown by Fig. 3, which is an illustration of the "Magna Charta" metal gauge. It should be noted that the numbers range upwards, No. 1 being the smallest size. This is

BIRMINGHAM METAL GAUGE (B.M.G.)

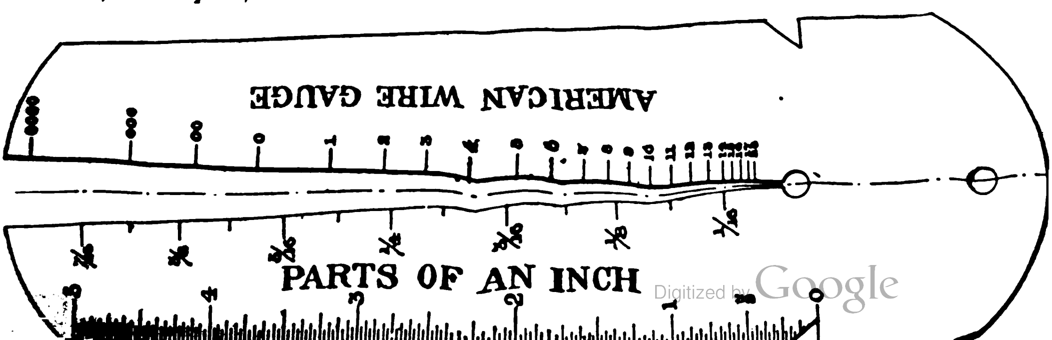
Table of Equivalents in Accordance with Metal Gauges as Sold

No.	Decimal Inch	No.	Decimal Inch
1	.0085	21	.069
2	.0095	22	.073
3	.0105	23	.077
4	.012	24	.082
5	.014	25	.091
6	.016	26	.102
7	.019	27	.112
8	.0215	28	.124
9	.024	29	.136
10	.028	30	.150
11	.032	31	.166
12	.035	32	.182
13	.038	33	.201
14	.043	34	.216
15	.048	35	.238
16	.051	36	.249
17	.055	37	.270
18	.059	38	.278
19	.062	39	.289
20	.065	40	.301

Note.—6 = 1-64th full; 11 = 1-32d full; 19 = 6th bare; 28 = 1-8 bare; 36 = 1-4 bare.

contrary to the usual practice in gauges. As the writer knows of no accurate reference for the equivalents, he has appended a table of the usual sizes—Nos. 1 to 40—which was kindly supplied by Messrs. J. Edelston & Sons, of Warrington, and confirmed by Messrs. Shakespeare & Sons. Sheet metal, such as is used in plate-workers' shops, in iron, mild steel, brass or copper, is generally gauged by the I.S.W.G. and not by the metal gauge. In addition to the metal gauge there is a special gauge for sizing hoop and sheet iron used in the Staffordshire District (abbreviated B.G.). This is of no particular interest to the reader, but is mentioned to put him on his guard against mistakes due to the similar abbreviation to the metal gauge.

There is a Continental gauge known as the Westfalia Millimeter Wire Gauge, the designating number referring to the unit of 1-10th of a millimeter. The best plate known to the writer is that of the "Progress" screw gauge plate (holed and notched), which is cut to these sizes. Pfeilschmidt gives full particulars in millimeter and inch sizes, and a note about the gauge as applied to "Progress" screws will be found in Section 7, "Screws, Threads and Twist Drills." There is also a Swiss-made plate sold by watch tool dealers in London giving one hundred sizes—*viz.*, from .1 to 10 mm. by tenths millimeters.

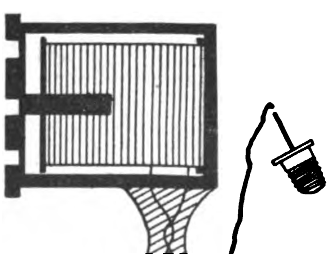


The above gauges constitute practically all and more than are necessary in ordinary workshop practice; and in concluding this portion of the subject, passing reference may be made to B.A. gauge plates giving screw, outside and tapping diameters for B.A. screws. Either whole or notch form gauges are made for outside diameters also. Special gauges of notch form are sold for testing lead and zinc sheet, plate glass and music wire (piano wire), each of which have their particular equivalents. The principal gauge in use in America is that known as the American, or Brown & Sharp, wire gauge; and in addition to this there is an American legal standard for sheets, which has the peculiarity of following the fractional inch decimal equivalents from ½ by 1-32 down to 9-32, and by 1-64 down to 1-16 in., after which finer fractions are given, which include 1-32, 1-64 and 1-128. An out-of-the-ordinary form of gauge is shown in Fig. 4, made by Messrs. Brown & Sharp to the American equivalents, one notch doing duty for all sizes. The only weak point in this design is that a slight strain would throw the whole out of caliber and render it useless, while bracing over the open end to strengthen would practically put it—for usefulness—on a par with the hole gauge, and consequently, not adapted for measuring wire in the hank. The question of strength in this design has been obviated by making them much thicker than gauges are as a rule. Messrs. Brown & Sharp also make a closed-over pattern. The writer has seen a similar form of folding gauge graduated to the I.S.W.G. The notched inch rule shown on the side is for measuring the overall length of countersunk headed machine screws, while the reverse side of the long notch is graduated to American machine screw gauge diameters. A similar form of gauge is sold to jewelers graduated to 1-1000ths of an inch. A good plate gauge is also made by the same firm and stocked by most London tool dealers for testing twist drills from 1-16 in. to ½ in. by 1-64, similar to Fig. 2.

HOW TO MAKE AN ELECTRIC VIBRATOR

STANLEY RADCLIFFE

A very simple and inexpensive vibrator can be made in the following manner: First, procure a wooden cup 2½ in. in diameter by 3 in. deep. Then make a cover, in which several ½ in. holes are bored. We now have the container which is to hold the working parts. A solenoid is made by winding enough No. 24 magnet wire on a ½ in. mandrel to form a coil 2½ in. long and 2 in. in diameter. This coil is then fastened to the bottom of the wooden cup by a couple of small screws. Secure a round piece of thin sheet iron 2½ in. in diameter, and attach to its center a piece of soft iron ⅝ in. in diameter by 1½ in. long. This is used in converting the electrical energy into mechanical energy. The disc is put over the coil and fastened in place between the cover and the cup. The connecting wires are brought out through the handle, as shown in the sketch. The device can be used in connection with alternating current, and by using an interrupter, it can also be used with a battery.



Practical Remedies for Motor and Generator Troubles

(*Concluded from page* 6)

for raising the armature pedestals or lowering the field frame bad sparking will occur at the brushes. Probably the

MECHANICAL DRAWING

P. LEROY FLANSBURG L. BONVOULOIR

CONVENTIONS—(Continued)

Although it is customary to represent V-threads in working drawings by the conventions explained last month, square threads are usually drawn as shown in Fig. 1. The construction is very simple.

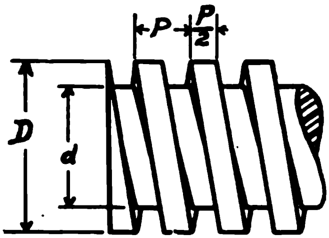
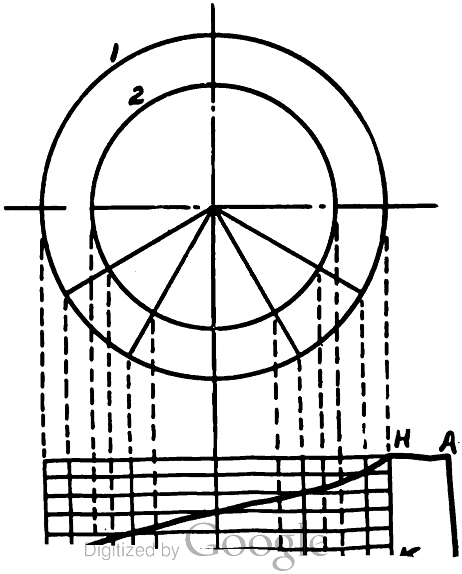


Fig. 1

It will be seen from the figure that the thickness of the thread is the same as that of the space between the threads, or, in other words, if the pitch of the screw is P, the thickness of the thread is $P/2$. If D is the outside diameter and d the root diameter, lay off lines parallel to the axis of the screw at distances $D/2$ and $d/2$ on both sides of this axis. Lay off distances equal to $P/2$ along one of these lines, and then project these points on the other lines. Connect the corresponding points on the outside and inside lines, getting the angles as explained in last month's article. The lines going behind the screw will be visible for only a very short distance, and care must be taken to get these right. A careful study of the cut will show the construction more

Draw circles 1 and 2 with diameters equal to D and d respectively. Divide the lower semi-circles into any number of equal parts by radial lines; in this case, 6 parts. From the intersection of these lines with the outside circle, draw parallel lines and extend them a short distance downward. On these lines lay off a distance HK equal to the half pitch, $P/2$, of the screw. Divide the distance HK into the same number of equal parts as was the circle, and project the outer extremities of the radial lines till they cut all of the lines which are drawn parallel to FK through the points which were found on HK.



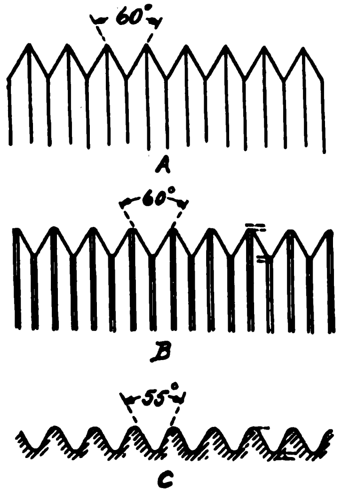


Fig. 3

We will then have a rectangle HKG. Point off the intersections of the first right-hand line with the first top line, the second right-hand line with the second line from the top, etc., and draw a smooth curve GH through these points of intersection. Proceed in the same way for the rectangle CJD, making CJ equal to $P/2$ and JD equal to the diameter of the smaller circle. The intersections of the radial lines with the inner circle are projected on the rectangle CJD, and the curve DC drawn as in the previous case. Carefully trace or scratch these curves on a piece of transparent celluloid, and cut out carefully in some such form as indicated by the letters $ABCJDEFGHA$. Care must be taken to have the sides AB and FE parallel to each other and to the axis of the circle. To use this templet, the screw is drawn as previously described, but instead of drawing straight lines between the corresponding points, the ends of the curve HG are placed on these points and the curve drawn. The curve DC is drawn in the same manner, but it will be noticed that one-half of the curve appears on one side of the thread, and the other half of the curve on the other side of the thread. It is obvious that a different templet must be used for different sized threads.

Different kinds of thread sections are used depending on the kind of work for which they are to be used. The various forms of thread sections are shown in Figs. 3 and 4.

The most common form is known as the V-thread, and is shown in Fig. 3*A*. The sides of the thread are inclined at an angle of 60 degrees. The sharp corners of this thread render it liable to injury, so that a modified form of the thread is generally used.

The Sellers or U.S. Standard thread, shown in Fig. 3*B*, is the same as the V-thread, except that the thread is shortened by one-eighth of the depth, both at top and bottom. The strength of the thread is materially increased by this means.

The Whitworth or English Standard, Fig. 3*C*, has the sides of the thread inclined at an angle of 55 degrees, and the tops and bottoms of the thread rounded off to one-sixth of the depth of the thread.

Where the thread is used to transfer motion, as is the case of the lead screw in a lathe, large bearing surfaces are necessary, and the square thread can here be used to advantage. It is not quite as strong as the V-thread, since it has only one-half of the shearing surface of the latter. Fig. 4*A* shows the usual form of square-thread, where the width of the thread, width of the space between threads, and the depth of the thread are all equal.

The Acme Standard, Fig. 4*B*, is the same as the square thread, except that its sides are inclined at an angle of 29 degrees. This gives increased bearing

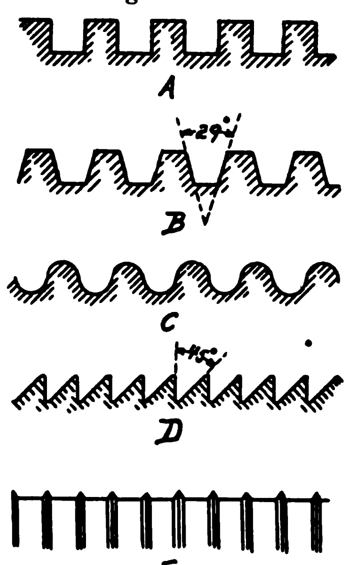
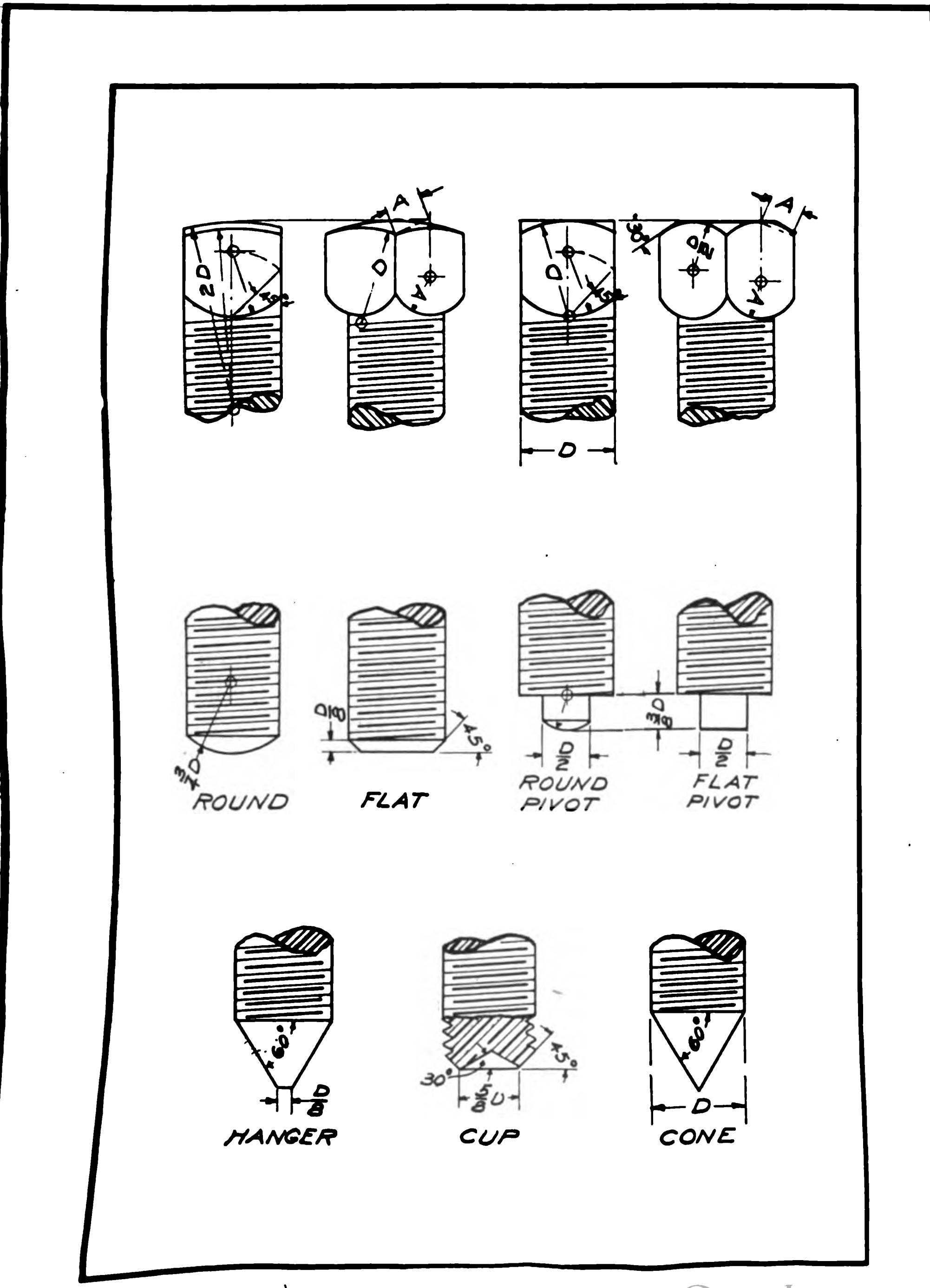


Fig. 4



A
2D
D
45°
D
A
30°
D/2
D
3/4 D
ROUND
D/8
45°
FLAT
3/8 D
D/2
ROUND PIVOT
D/2
FLAT PIVOT
60°
D/8
HANGER
45°
30°
5/8 D
CUP
60°
D
CONE

Fig. 5—Machine Screws

and shearing surfaces, and also permits of a clasp-nut being used.

Fig. 4*C* is a modified form of the Acme Standard with rounded edges. It is used for rough work and may easily be cast, making its manufacture much less expensive.

Fig. 4*D* shows a form of thread which is used where the pressure on the thread is always applied against the same side. One of the sides is perpendicular to the axis of the screw, while the other is inclined at an angle of 45 degrees. The tops and bottoms are slightly flattened.

MACHINE SCREWS

No.	Threads per inch	Dia. Body	Dia. Heads Flat	R'd	Fil.	Lengths
2	56	.0842	.163	.155	.133	3/16 – 9/16
3	48	.0973	.190	.179	.155	3/16 – 5/8
4	32–36–40	.1105	.216	.203	.175	3/16 – 3/4
5	32–36–40	.1236	.243	.227	.199	3/16 – 7/8
6	30–32	.1368	.269	.252	.218	3/16 – 1
7	30–32	.1500	.295	.276	.240	1/4 – 1 1/4
8	30–32	.1631	.321	.294	.261	1/4 – 1 1/4
9	24–30–32	.1763	.348	.324	.281	1/4 – 1 3/8
10	24–30–32	.1894	.374	.348	.304	1/4 – 1 1/2
12	20–24	.2158	.427	.393	.345	3/8 – 1 3/4
14	20–24	.2421	.479	.437	.389	3/8 – 2
16	16–18–20	.2684	.532	.487	.430	3/8 – 2 1/4
18	16–18	.2947	.585	.525	.471	1/2 – 2 1/2
20	16–18	.3210	.637	.569	.520	1/2 – 2 3/4
22	16–18	.3474	.690	.611	.556	1/2 – 3
24	14–16	.3737	.742	.653	.601	1/2 – 3
26	14–16	.4000	.742	.694	.643	3/4 – 3
28	14–16	.4263	.795	.736	.692	7/8 – 3
30	14–16	.4520	.848	.777	.724	1 – 3

Certain standard forms and dimensions of screws are generally used in practice, and are variously known as *Machine Screws*, *Set Screws*, *Cap Screws*, etc. The following tables and cuts should be made into study plates, similar to Study Plate 10, as this work will give invaluable practice in lettering and the plates will also be of considerable value as reference plates. Each kind of screw with its accompanying tables should be put on a separate plate. The arrangement is left as an exercise to the student, Plate 10 merely serving as a model. Number the plates as follows:

Machine Screws—Study Plate 6
Pipe Threads—Study Plate 7
Cap Screws—Study Plate 8
Cap Screws—Study Plate 9

There are three kinds of machine screws, as shown in Fig. 5, and they are known as *Flat Head*, *Round Head* and *Filister Head*. Assume a diameter of screw, and you can at once obtain its dimensions from the tables. All threads are U.S. Standard. Machine screws vary in length from 3/16 in. to 1/2 in. by 16ths; from 1/2 in. to 1 1/2 in. by 8ths; and from 1 1/2 in. to 3 in. by 4ths.

The tables may be put at the top or at the bottom of the plate, as preferred, care being taken to have the plate well balanced.

Fig. 6 shows the standard pipe thread. It will be noticed that the threaded end is tapered 3/4 in. per ft., and that the last two threads are cut off at the top, while after a distance *L* from the end, the threads are also filled in at the bottom.

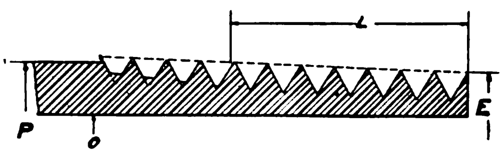


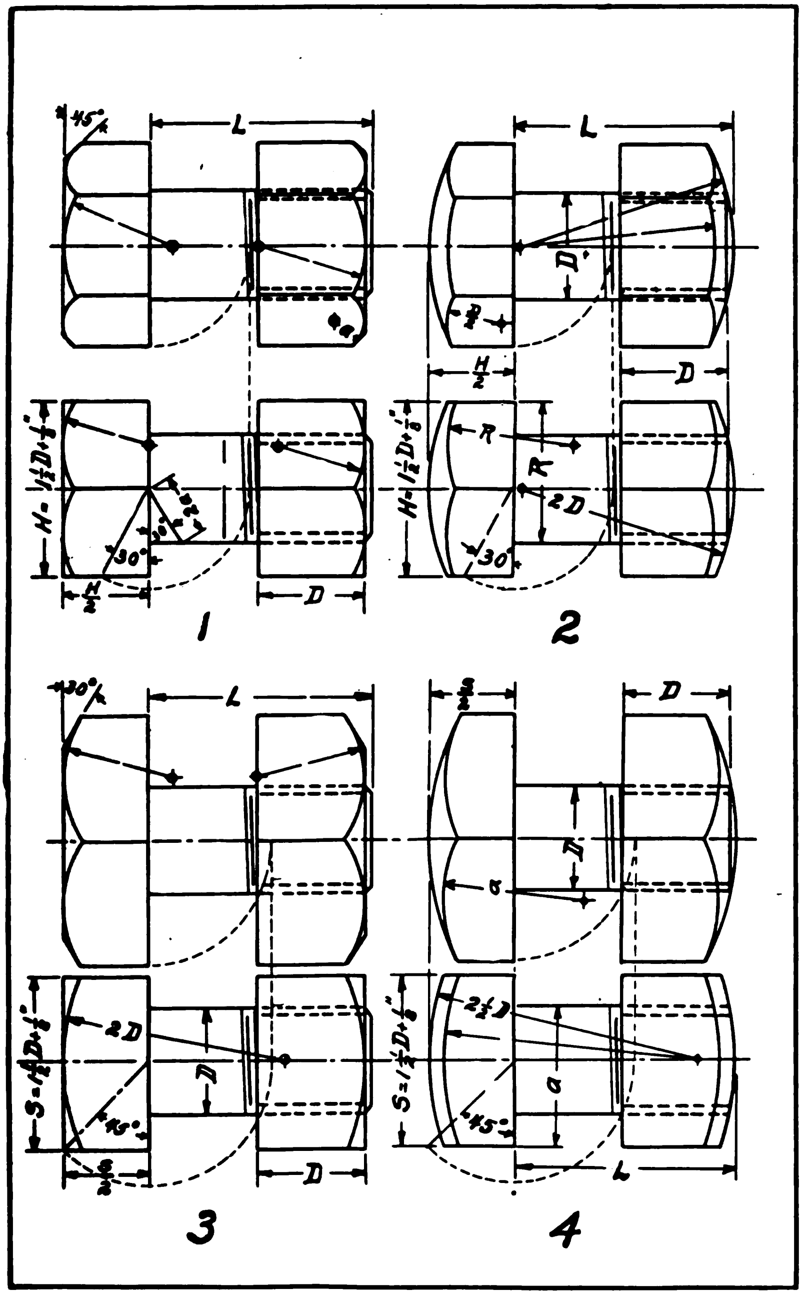
Fig. 6—Pipe Thread

Assume any desired pipe diameter, and, as before, you can readily get the dimensions of the standard thread from the tables.

Fig. 7 shows two different kinds of heads used on Cap Screws, *i.e.*, Hexagonal Heads and Square Heads. The construction is clearly indicated in the figures. *H* is the distance between opposite faces and the length of the 30-degree line, drawn from the axis to the edge of the head, gives the half-width of the other view of the head. The lengths *T* may vary by 4ths between the limits given. $T = \frac{3}{4}L$ up to and including 1 in. in diameter and 4 in. long.

STANDARD PIPE THREAD

Pipe Size		1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	4 1/2	5	6	7	8	9	10
Outside Dia. Pipe	P	0.54	0.68	0.84	1.05	1.32	1.66	1.90	2.38	2.88	3.50	4.00	4.50	5.00	5.56	6.63	7.63	8.63	9.69	10.75
Inside Dia. Pipe	O	0.36	0.49	0.62	0.82	1.05	1.38	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]



Study Plate II

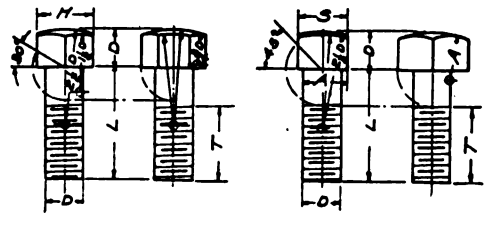


Fig. 7—Cap Screws

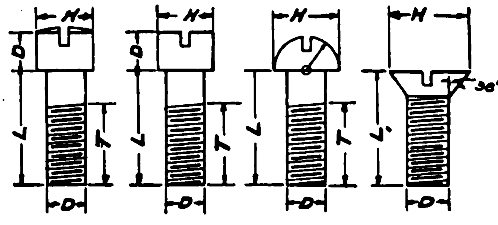


Fig. 8—Cap Screws

There are also four other kinds of Cap Screw heads, *viz.*: Filister, Round, Button and Flat. The construction is similar to that of the previous ones, and is shown quite clearly in Fig. 8.

Study Plate 10 shows the various forms of Set Screw hea[illegible] and points. The heads are known as Round square head and Chamfered square flat head. The points are known as round, flat, round pivot, flat pivot, hanger, cup and cone. The differences between the various kinds of points are clearly shown and their construction should not be difficult.

Study Plate 11 shows in detail the construction of the U.S. Standard Bolts, both hexagonal and square, with both flat and spherical tops. All of the dimensions are given in terms of the diameter. After finding the width *H* of the bolt head, the width of the other view is obtained by drawing a 30-degree line and projecting the length of this line on the other view, in the same way as for the Cap Screws.

The dimensions for the border lines of these six study plates are the same as for all the study plates which have been given.

All of these study plates should be drawn carefully and saved for future reference, as a designer is constantly using these standards in his work. The lettering should be done carefully and neatly, and no fancy lettering should be used, a simple kind easily made and easily read being preferable.

Such study plates, which have been drawn by readers of the ELECTRICIAN AND MECHANIC and sent in for criticism, show remarkably good workmanship for men who are not draftsmen. If any readers would like to have their work criticised, send it in to the ELECTRICIAN AND MECHANIC, addressed to the Mechanical Drawing Department and inclosing return postage. In order to make this department of the magazine still more helpful to the readers, a few Study Questions will be given from time to time. It will be excellent practice for the novice to try to answer the questions.

STUDY QUESTIONS

1. Draw two converging straight lines which make an angle of 30 degrees with each other. From some point within the angle and at a distance of 3 in. from the vertex let fall perpendiculars to each line.
2. What may be said of the angles and sides of a quadrilateral which encloses the maximum area with a given perimeter? Name the figure.
3. Inscribe a regular octagon in a circle.

CAP SCREWS

Dia. Screw	Hexagonal Head		Square Head	
	H	L	S	L
1/4	7/16	3/4 to 3	3/8	[illegible]
5/16	[illegible]	[illegible]		

CAP SCREWS

Dia. Screw	R'd & Filister H'd		Flat Head		Button Head	
	H	L	H	L	H	L
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] to 1 3/4	7/32	3/4 to 1 3/4

THE PRODUCTION OF ACCURATE SCREW-THREADS IN THE LATHE—Part I

FRANCIS W. SHAW

Strange though it may seem, it is nevertheless a fact that very few turners are sufficiently gifted to be able to turn out an accurate screw-thread in the lathe. [illegible] competent screw-cutter can cite many little experiences from his apprenticeship days of difficulties encountered and overcome. It is not an uncommon thing to see advertisements for turners bearing the words, "must be accustomed to screw-cutting." To the tyro, no doubt, the production of clean, accurate threads is by no means a simple affair. Perhaps a careful analysis of the difficulties met will afford some clue to means of annihilating them.

First of all, what are the main difficulties? These will be best seen by a critical examination of the first finished production (perhaps unfinished would be the more descriptive term) of the embryo screw-cutter.

Here is a scrap job, the result of one of the first attempts to cut a Whitworth thread. What does an examination disclose?—taperness, smaller at the commencement; drunkenness, bottom of space too sharp; general roughness, interrupted by several deep gashes—features, it may be imagined, not inherently characteristic of the Whitworth form of thread. True, the Whitworth thread is one of the most difficult threads to master; nevertheless, the difficulties are not insurmountable. What lack does our examination show on the part of its producer? Merely lack of the knowledge that a chaser is but a finishing tool, not a tool for gouging out vast quantities of material. The defects seen in the work show that the chaser has been used to remove far more material than necessary. Inability to maintain

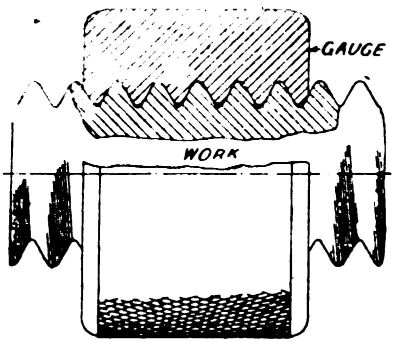


Fig. 2—Showing External Thread cut deeper than Standard

of the screw, aided a little, perhaps, by lack of homogeneity in the material, has resulted in producing a taper, rough and drunken thread. Further, a screw-cutting tool ground to a sharp V has resulted in a thread sharp in the root angle, ready to snap off at the slightest provocation.

The lesson to be learned is surely obvious. Greater attention must be devoted to accuracy of tool forms, accurate setting, and manipulation of tools. Before going into means for insuring such care and accuracy, let us proceed a little further in our exploration of results.

Here is a square thread, or, rather, the result of an attempt to produce a square thread. It suffers from many complaints, chief amongst which are: some threads thicker than others, the commencing threads appreciably thicker than the rest; flanks of the threads are rough, and "out of square"; the nut is with difficulty started on, then becomes "easy." Obviously another case demanding consideration.

Another example: A double-threaded screw, one land of which is distinctly wider than the other, showing a lack of of ensuring equal

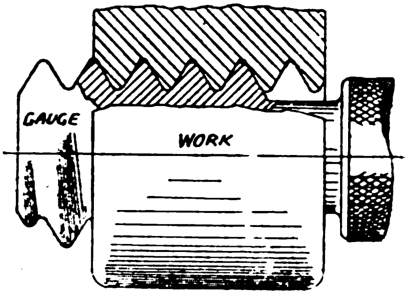


Fig. 3—Showing Internal Thread cut deeper than Standard

its advantages, derived from a stronger resultant screw, and in the durable form of the round-pointed tools used in its production, it also has many disadvantages over the sharp V or flatted V threads, in that these last forms are more easily generated from first principles. Difficulties of gauging, too, are rather less intense.

In cutting any form of thread there are two distinct cases to be met. First, where the product is merely to form part of some mechanism; second, where the product is a thread-forming tool, such as a tap or die. A recognition of this difference will permit of some little saving of time in work of the first category. In the production of these threads the root diameter is not a very important factor: hence production will be slightly facilitated by using a threading-tool, having its point slightly less blunt than the theoretical form. Figs. 2 and 3 show how this will affect the work. It is obvious that this will reduce somewhat the work of the finishing tool or chaser, particularly at the ends of the teeth where wear is most rapid.

The essentials to success in screw-cutting, in addition to skill on the part of the operator, are:

(*a*) An accurate machine.

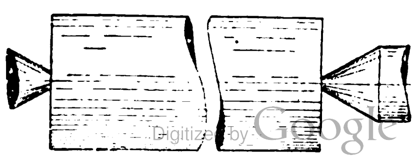
(*b*) Accurate and convenient tools.

(*c*) Accurate setting of tools in relation to the work.

Absolute perfection in machines—or anything else—is recognizedly impossible of acquirement; but the greater the vious; these must not be overlooked. The lathe-spindle and guide-screw must be free from end travel, which may be consequent in imperfect arrangements for taking the end thrust. The author has known cases where thrust washers and locknut inclined to their axes have resulted in considerable end travel. A case in his own experience will serve to illustrate the importance of this factor.

A DEFECTIVE LATHE

The first job of screw-cutting on a new lathe was a square thread screw of 1/10 in. lead (10 threads per inch, single). Examination of the finished job showed an appreciable difference in thread thickness at different points. A second screw was commenced with a view of assuring whether the defects on the second screw were merely accidental or due to some imperfection in the lathe. The defect being repeated on the second screw led to the conclusion that the machine was at fault. Suspicion was, naturally, directed first of all to the guide-screw; but careful testing proved the suspicion unwarranted. The change-wheels then underwent casual examination; but a little thought, aided by a rough calculation—showing that quite a big error would have very little result on the work—quickly disposed of this. Examination of the spindle afforded no clue. Finally the trouble was traced to its lair, in the thrust-washers and locknuts, which retained the screw from bodily end movement. Not only were these found to have their acting faces unsquare with the axis of the screw, but the bracket facings upon which they bore were also "out of square." Result—end travel. A more critical examination of the work showed that similar inequalities repeated themselves every ½ in. in the length, corre-



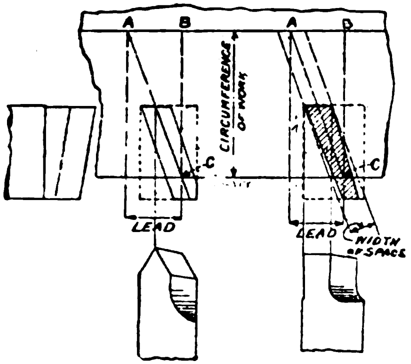


Fig. 5—Laying Out Angle of Lead

sponding with the lead—½ in.—of the guide-screw.

THE TERMS "PITCH" AND "LEAD" DEFINED

Before proceeding further it will be well clearly to define the terms "pitch" and "lead," some little confusion existing in their use. Throughout this article, "pitch" will be used to denote the distance at which adjacent threads are *pitched*; "lead"—the distance traveled by the nut for each turn of the screw. In a single-threaded screw, the pitch and lead will, of course, be equal; but in the multiple thread screws the lead will be as many times greater than the pitch as the value of the multiple. Thus, a screw which in one turn compels the nut to travel 1 in., and having a quadruple thread, would be spoken of as 1 in. lead, ¼ in. pitch.

Accuracy in the machine is of prime importance. Next in importance comes accuracy in tools. If results are to be certain, it is not sufficient to grind tools in any haphazard way, rough out the thread and depend on the chaser for correcting the resultant inaccuracies. Means, too, must be provided for checking the work, not merely when it is finished, but during every stage in its progress.

SETTING TOOLS IN CORRECT RELATION TO WORK

In this case it is necessary to assume th...

care must be exercised in setting the tool-angles in correct relation to the work. One method of insuring this result is shown in Fig. 4. This entails the grinding of the side of the tool against which the square rests, and the location of the cutting angles in relation to this side. This is far better than locating from one of the special angle-gauges usually sold for the purpose. In practice it is very difficult to locate from the comparatively short lengths of cutting edge in the V-thread tool.

Fig. 5 shows how the tool must be ground to conform to the lead-angle of the thread. The illustration is a development of the circumference of the work. Any plane surface, such as a marking-out plate, surface-plate, even a block of wood or piece of paper will serve the purpose. Two vertical lines, *A* and *B*, are drawn the same distance apart as the lead. It will be evident that the angle of the diagonal *AC* will corre-

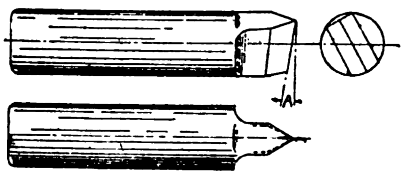


Fig. 7—Showing change in Plan Angle, when Cutter is Tilted

spond with the lead-angle of the thread. To this angle the end-angles of the tool must be ground, and, in the case of a square-thread tool, the sides also, the latter being ground to give some 4 to 6 degrees bottom clearance, as shown in the right-hand view. The mathematician will not need to employ this graphical method, for to him it will be obvious that the lead-angle whose sine is

$\frac{l}{\pi d}$ where l=lead and d=diameter

is the correct angle to which tools must ... Theoretically, a tool thus

TOOLS WITH CYLINDRICAL SHANKS

More universal tools are those made from round stock, held in a special tool-holder, as shown in Fig. 6. This form of tool is open to the objection that the cutting-angle changes as it is rotated to the correct lead-angle. Fig. 7 shows the change in plan-angle due to rotation from normal. The objection is serious only in extreme cases, and may be overcome by making several tools, each covering a small range. Increasing the angle *A* lessens the difficulty, and is a useful expedient in fine threads. For convenience in showing the change in plan-angle, the lower view has been improperly projected.

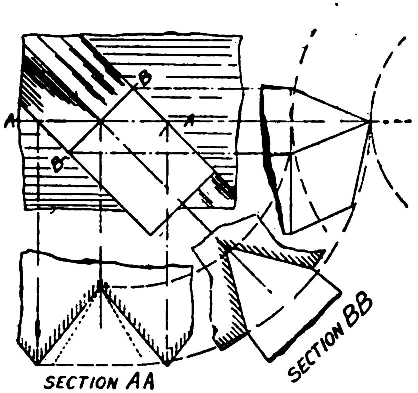


Fig. 8—Showing Result of making Cutting Face Normal with Thread Angle

INFLUENCE OF INCORRECT SETTING OF TOOLS

The cutting or top face of screw-cutting tools must always be parallel with the line of centers or axis of work. Many turners make a mistake in grinding the face normal or at right angles to the lead-angle, as denoted by the line *BB* in Fig. 8, a geometrical analysis of the resulting thread deformation in an extreme case. Section *BB* is a view of the tool at right angles to its top face. In this view the

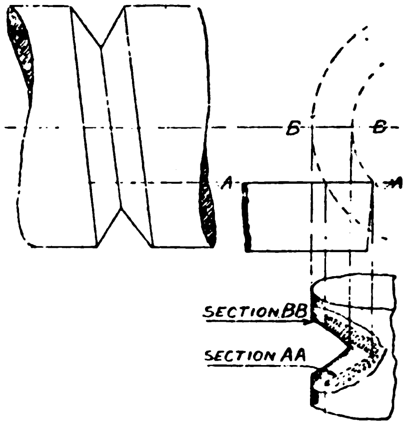


Fig. 9—Showing Effect of Setting Cutting Edge Below Center

depth, however, remains the same when the point of the tool is in the position shown. Section *AA* shows clearly the effect, the dotted lines denoting the correct form.

Fig. 9 shows the result of setting the tool below the center line. If the tool is fed in the theoretical depth, the true section will be on the plan *AA* in the upper view. In plan, the section at this plane is shown in Section *AA*. The axial section shows (Section *BB*) that the thread where it should be of the theoretical form is much shallower, and the flanks are curved. A careful consideration of Figs. 8 and 9 will be sufficiently convincing of the importance of keeping the plane of the top face in the line of centers, and of avoiding grinding the top face normal with the lead-angle.

TO INSURE CLEAN THREADS

The chips must peel away freely. To insure this—a well-understood fact—endeavor must be made to produce flat chips. The superiority of straight cut-

ting-edges in modern turning and planing tools over the old-fashioned round-nose tools is not gainsaid by the practical man. The theoretical aim points out that a chip of curved section increases the friction on the tool-face, causing more rapid destruction than a chip of flat section. Fig. 10 illustrates this point. The V-chip shown is obviously more difficult to shear-up than the flat chip; hence, greater pressure is applied to the tool-face. In cutting a V-thread the chip will be flat if the tool is fed in at the angle of the thread, as shown on the left-hand view, the small section on the work between centers showing the nature of the chips removed at successive cuts. In this way the angle of the thread at one side is controlled not merely by the tool form but by the angle of the inward feed of the slide-rest.

This suggests one method by which extra accurate V-threads may be produced. First, rough-out the thread with an ordinary V-tool, afterwards finishing each flank independently by means of side-tools controlled in their inward feed by setting the slide-rest over to the requisite angles.

(Concluded in February Issue)

WHEN BUYING A GAS-ENGINE

Decide on the maximum amount of power you must have. Remember if your engine is to be used on the farm that in addition to running the cream separator, churning, running washing machines, corn sheller, etc., you will often want to pump water, saw wood and do other work where one or two extra horse-power comes in handy.

Buy your engine through a reputable dealer whose place of business is near you. Such a man will take a personal interest in having your engine run well and you can, if necessary, get parts quickly.

It does not pay to buy your engines from a comparatively unknown concern a long distance from you. Such people as a rule make their customers pay for their experiments, repair parts cost high, and take a long time to get, and they have no personal interest in whether or not you succeed in using the engine properly.

Gasoline as fuel gives the best service for a small engine, but kerosene and other heavy oils are rapidly coming into favor for the larger sizes. An experienced engine salesman will tell you which is the best fuel for your purpose and which will cost you the least.

If ... it to drive machinery that

slow-speed engine-timed magneto with visible timing feature. This machine eliminates all batteries, coil and switch, and furnishes the current for sparking the engine as long as the engine runs.

These slow-speed alternating current magnetos are the same as used on automobiles only the more simple and reliable make-and-break igniters are used on the engines instead of the spark plug as used on the automobile.

As the magnetos have no belt or friction wheel and require no speed governor, they should not be confused with the cheap little sparking dynamos used for this purpose.

Ignition troubles are by far the largest proportion of troubles that beset the engine user. The built-in engine-timed magneto eliminates these and really costs no more than a set of high-grade closed-circuit batteries with the necessary coil and switch.

After getting the engine, read the instruction book carefully before trying to operate same. Don't let some one who has another make of engine tell you how to start and run yours, as instructions for different kinds of engines differ. Here is where purchasing your engines

The troubles with engines are usually dirty igniter points, stopped up gasoline or water pipes, lack of oil, or the valves are out of adjustment. Any of these troubles are easily remedied by any one with common sense without having to take the engine apart. An imitation expert can always be told by pretending to know exactly what is the matter with the gas-engine almost instantly and by the fact that he will immediately want to tear the entire engine apart.

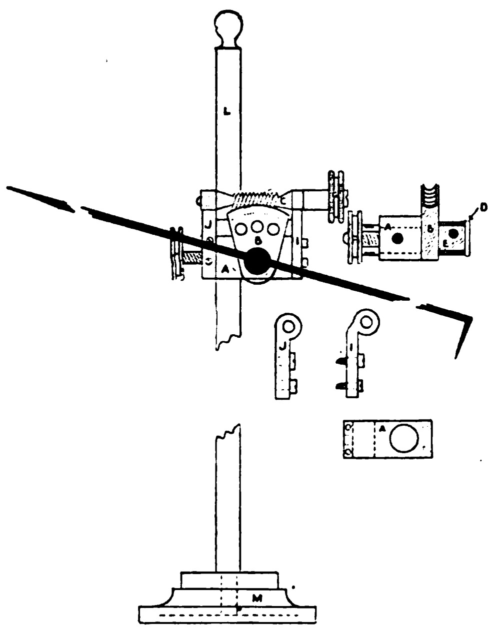
On engines having a battery or the cheap friction-driven ignition sparkers, such as many of the older engines are equipped with, ignition troubles were plentiful and these require an expert for their location and remedy, but with the more modern magneto-equipped engines these troubles are eliminated; and in fact the only thing that can go wrong is the timing, as the magneto revolves in time with the engine unless a gear should slip in some way. Now, a magneto should be selected in which provision is made for checking against this slipping, without the necessity of opening the magneto. The choice of an engine equipped with a magneto of this character will result in good reliable service.

If the engine is to be used in one place, bolt it down to a good foundation. Don't bolt it to a lot of loose timbers set on a dirt floor.

Get a good storage tank for the liquid fuel and put it preferably under ground. Read instructions sent with the engine and see that the tank isn't buried so deep that the engine fuel pump won't draw.

A USEFUL SCRIBING-BLOCK

I have the pleasure of introducing a novel mechanical adjustment applied to a scribing-block, says Wm. Barnett, in a recent issue of *The English Mechanic and World of Science*. I think the enclosed rough sketch will give your readers a clear idea of the above. They may find some difficulty in making the female screw on the quadrant. I would suggest to them to make a steel screw ¼ in. diameter, 28 pitch; then file some groove on an angle along it, and use same as hob in lathe; then place quadrant on slide-rest, to revolve on center, and be sure that center edge of quadrant is central with hob. All parts are of mild steel, except quadrant (brass) and iron casting for bases. The following are the measurements in mm.: *A* 35+16+16, *I* and *J* 35+4.5, *B* 28+7, screw 28 pitch, the millhead *G* on end of screw *C* fitting on taper with 6 *BA* to tighten same. It must be noticed that *J* is fastened to face of block *A*, and *I* to the end, allowing the quadrant more movement, and the screw-holes in *J* must be elongated to take up loss of time in *C* and *B*. The holder of *K* 4.5—that is to say, the bolt *D*—must be easy-fitting in *A*, also the loose sleeve *E*; but *B* must fit tight on *D*. Length of *L* 255+9, *K* 164; weight complete 1 lb. 5 oz., base 12, mechanical adjustment part only 5.



Useful Scribing-Block

The mechanical efficiency of a steam engine, plus its necessary auxiliary appurtenances, is but little in excess of that of a gas-engine of equal indicated horsepower.

The phenomena of the storage battery were first observed by a French chemist, Planté, in 1860.

REAL OR TRUE CONSERVATION

In the preface to Bulletin 47, Notes on Mineral Waste, written by Charles L. Parsons, chief mineral chemist of the Bureau of Mines, which has just been issued, Dr. Joseph A. Holmes, the Director, gives his views upon what he terms real or true conservation.

Dr. Holmes says: "During the past year, in producing 500,000,000 tons of coal we wasted or left underground, in such condition that it probably will not be recovered in the future, 250,000,000 tons of coal; we turned loose into the atmosphere a quantity of natural gas larger than the total output of artificial gas during the same period in all the towns and cities of the United States; we also wasted or lost in the mining, preparation and treatment of other important metalliferous and non-metalliferous minerals from 10 to 15 per cent. of the year's production of such minerals. These losses serve to indicate the importance of inquiries and investigations by the Federal Government for the purpose of lessening the waste of essential resources—investigations on the same general lines as those looking to a reduction in the loss of life in the mining operations of the country and the far more extensive investigations looking to the more efficient production and use of agricultural products, both of which are being conducted by the Federal Government.

"In a consideration of the possible activities of the individual, the State, and the Federal Government in behalf of a less wasteful use of our mineral resources certain facts and principles should be kept in mind.

"That the present generation has the power, and it will exercise the right, to use as much of the country's resources as it actually needs; there can and there will be no such thing as stinting the present generation by bottling up resources for the use of the future.

"That the Nation's needs are not likely

"That the men of this generation will not mine, extract or use these resources at continuous financial loss to themselves in order that something may be left for the use of future generations; there can be no such thing as a mineral industry without profits.

"Furthermore, it should be clearly understood that the mineral resources of this country have required long ages for their accumulation and that of these resources the Nation has but the one supply. There are no known substitutes available to meet the Nation's further needs when that supply will be exhausted and, to the best of our present knowledge, this one supply must serve as a basis for both the needs of the present and the far greater needs of the future.

"In a higher way our mineral resources should be regarded as property to be used and to be held in trust with regard to both the present and the future needs of the country. It should be remembered that neither human labor nor any human agency has contributed to their origin or to their intrinsic value, and that whatever rights the individual may possess have been derived from the General Government and from the State as the original owner. The State does not surrender its right, and should not neglect its duty, to safeguard the welfare of its future citizens by preventing the wasteful use of these resources. Though the individual may claim the right to use the resources in proportion to his needs and the needs of the community, he certainly has no right to waste that which is not needed for present use but is certain to be needed hereafter.

"Those in charge of the investigations of the Bureau of Mines recognize the rights and duties of the Federal Government as being limited to the carrying on of inquiries and investigations with a view to determining the nature and extent of this waste of resources, the means by which it may be diminished,

sary inquiries and investigations have been conducted and the results put in shape for publication.

"In the preliminary work along these lines, the representatives of the bureau have received the cordial co-operation of the engineers and chemists associated with the varied mineral industries of this country and also of the owners and the operators of the mines and the metallurgical plants."

Copies of this bulletin may be had by addressing the Director of the Bureau of Mines, Washington, D.C.

CLOCK RUN BY ELECTRICITY FROM THE EARTH

The only piece of machinery in the world to be operated entirely by electrical forces drawn from Mother Earth is now running at Camp Hill, Pa. It has been in continuous operation since 1870, with the exception of a short period involved in its transfer to several different localities. In the late '60's Daniel Drawbaugh, to whom every one in that locality gives credit for inventing the telephone, and who succeeded his inventions in telephony by constructing hundreds of marvellously ingenious mechanical and electrical devices for furthering the world's work, conceived the idea that he could make a perfect clock operate under the guidance of latent electrical forces in the earth. Time has shown that Drawbaugh has come closer to perpetual motion than any other inventor.

In the Drawbaugh timepiece, which stands about 6 ft. in height, and is unlike all other clocks, the pendulum is the motor. It is suspended on an edged pivot of hardened steel in order to reduce friction to a minimum. This pendulum weighs about 45 lbs., its central rod terminating midway between the ball and the point of suspension, where there is an ordinary permanent magnet. Fastened against the back part of the clock base at right angles to the permanent magnet is an electromagnet, the wire of which runs into the ground, the earth becoming the battery feeding the electromagnet.

When the pendulum is swung away from the perpendicular, the opposite poles of the two magnets first attract and then repel, thus keeping up the oscillation. At the top of the case the wheels are fastened to tubes or hollow spindles which are suspended in turn upon steel studs or pins, which in their turn are [illegible] into a main metal base receives its motion from two pawls pivoted upon the upper crossbar of the pendulum rods.

One remarkable feature in the construction of the clock is that there are only four bearings that are subjected to the least friction. Drawbaugh confidently stated that his clock would run for hundreds of years before any part would have to be renewed. In making the clock ready for work it is necessary to dig a hole in the earth about 3 ft. in diameter and 6 ft. deep. Metal plates are placed in the hole with enough coke to hold moisture, and the timepiece can be run so that it will not gain or lose two seconds in a year.

The clock is now running in the office of Charles H. Drawbaugh, the inventor's son, at Camp Hill, where many visitors marvel at its simplicity and the ingenuity displayed in its construction.—*N.Y. Sun.*

His Greatest Gift

"That man over there with the white hair gave me the greatest gift I ever received," said one successful business man to another. "It wasn't money," he continued in answer to his companion's look of interrogation, "it wasn't any material substance. When I was a youngster, struggling to get ahead, he listened to me as I told him my dreams and told me that he believed in me and in my ability to make good. He also said that he would keep watch because he wanted to see me grow as he knew I would grow. He probably forgot all about it years ago. But the effect of his speech was such that I have never forgotten how I felt when he said: 'I believe in you,' and I've never been able to shake off the feeling that he has always watched me. He has in that way done more than any other man to help me win the success

CONSTRUCTION OF AN ARMATURE LAMINAE NOTCHING PUNCH

CHAS. F. FRAASA, JR.

The amateur, after having carefully designed a small dynamo or motor, often finds it necessary to modify his design because of not being able to find suitable armature laminae. Or, he may have to make his design with a view of using some standard laminae, which is difficult under certain conditions. The following design provides a means of avoiding this difficulty. The punch is easily constructed, at little expense, and besides making it possible to use any size and type of disc, enables one to make the discs cheaper than they can be bought.

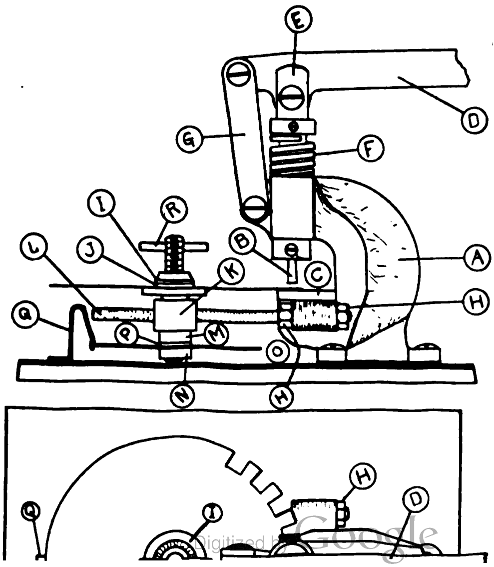
The construction of the punch is illustrated in Drawing 1. It consists of a castiron frame *A*, the punch and die-plate *B* and *C*; an indexing support for locating the slots; a lever *D* actuating a plunger *E* carrying at its lower end the punch *B*.

The pattern for the punch frame, Fig. 1, Drawing 2, should be made of soft white pine. For this purpose, get six pieces of 5 x 5½ x ¼ in. white pine. The pattern will be made in two parts, and will be divided along the line *AB*, Fig. 1. Each part will then be made of three of the ¼ in. pieces, which should be glued together. Then clamp the two parts of the pattern in a vise and drill the ¼ in. holes *A* in them. These holes are for ¼ in. dowel-pins, which hold the pattern together while working it, and also help to locate the two parts when moulding. Then lay out the design on the pattern, and trim it down with a sharp knife to the dimensions and shape shown in the drawing. The projections *B* which support the indexing device should be carefully glued in place after trimming to shape.

Almost any foundry will make this casting for you at a small expense. If the casting has not been cleaned when you get it, carefully scrape and finish all parts with a file and emery cloth. Plane or file the top surface *C*, the bot- Drill the ¾ in. hole *H*, in the top of the casting for the plunger, and the holes in the base lugs for bolting the punch to a base. The side holes *G* in the casting are dril ed ⅜ in. in diameter. When doing this the casting should be bolted up against an angle plate to insure that the holes will be parallel. The punch frame may then be given a coat of black paint or enamel.

The punch plunger, Fig. 2, is turned down from a piece of steel rod to the dimensions indicated. The collar *A* is removable, being fastened in place by the set-screw *B*. The object of this collar is to hold the spring *F*, Drawing 1, in place. The upper end of the plunger has a ¼ in. slot cut in it to receive the lever, Fig. 3. Drill the ⅜ in. hole *C* in this end also. In the other end drill a 5/16 in. hole to receive the punch, and the hole for the set-screw *D*, which binds the punch in place.

The spring *F*, Drawing 1, may be made from some stiff spring wire. This should be heated red and plunged into lubricating



oil and then into water to harden it after it has been wound, or the spring may be cut from any old spring which may be available.

The lever, Fig. 3, is cut from some strip iron or steel 1/4 in. thick. The long end should be forged to a tang, to take the handle, Fig. 5. The side connecting pieces *G*, Drawing 1, are also cut from strip iron or steel 1/4 in. thick. They are dimensioned in Fig. 4. Two of these will be required. The lever handle, Fig. 5, should be turned from some hard wood, and finished with a coat of paint or varnish. On one end place a ferrule, and drill a hole for the tang of the lever.

The indexing device is dimensioned in detail in Figs. 6 to 12. The side guides are turned from steel rod, the 3/8 in. portions of each being threaded on both ends as shown. Two 3/8 in. nuts, *H*, Drawing 1, should be provided for each rod. The mandrel, Fig. 7, can be turned from a piece of 3/4 in. steel rod. Both ends are threaded, and one end has drilled in it a 1/8 in. hole. This hole should be reamed out so that a 1/8 in. rod will enter it easily.

The nut, Fig. 8, should be turned down to size, and bored and tapped to fit the 3/8 in. mandrel, Fig. 7. The washer *J*, Drawing 1, dimensioned in Fig. 9, should have a circular projection turned on it as shown, the diameter of the projection being equal to the diameter of the shaft hole in the core disc. For each disc having a special shaft diameter, a special piece *J* will have to be provided. The washer, Fig. 10, fits down over the disc, and the projection on the part, Fig. 9, which should have a hole in it of a slightly larger diameter than the diameter of the projection on the part 9.

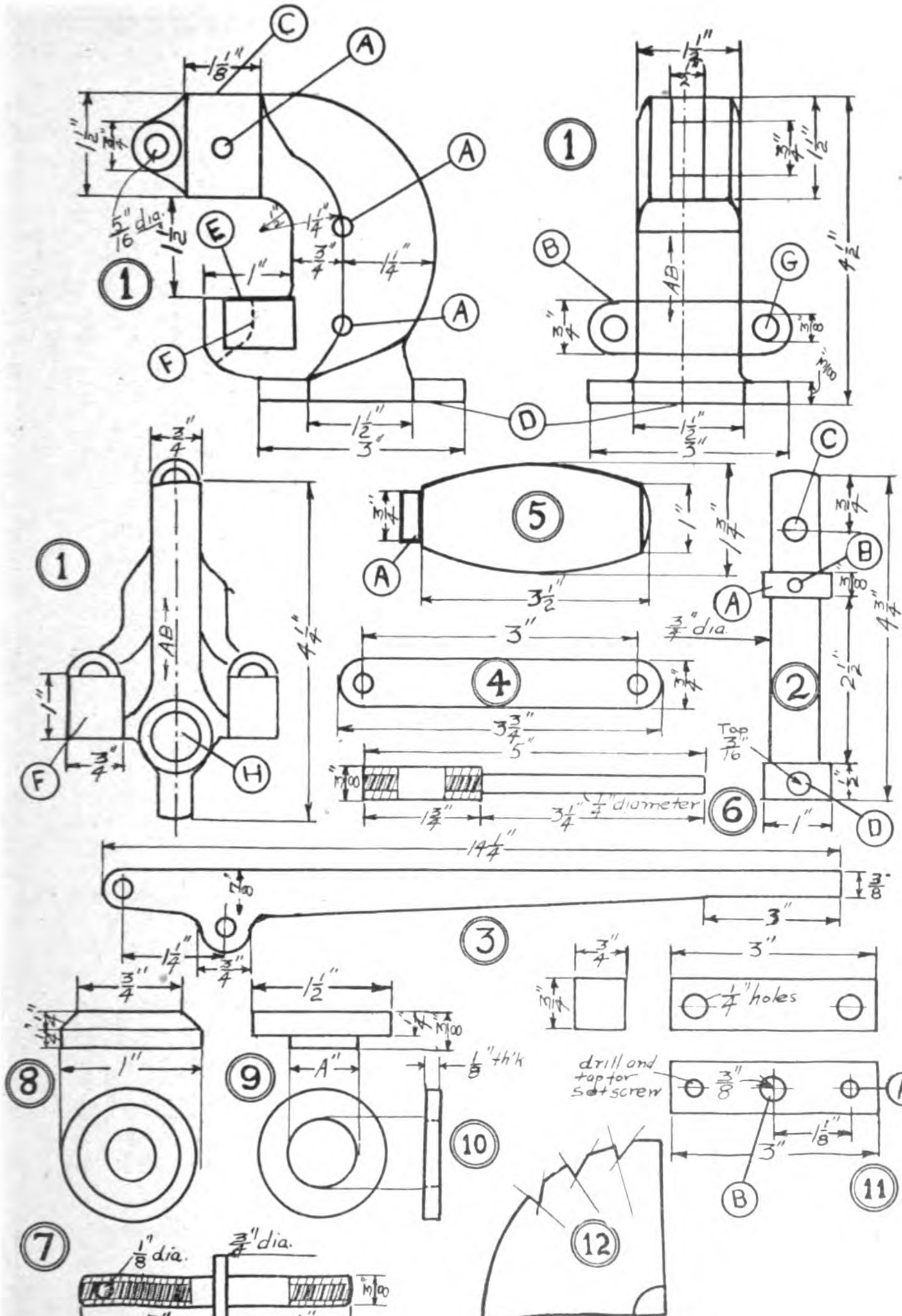
The mandrel is mounted on the part *K* shown in detail in Fig. 11. This is a piece of steel or iron having two holes drilled in it to enable it to slide on the side rods *L*. These holes should be reamed so that it will slide freely. The two holes *A* are drilled and tapped for set-screws to bind the slide in certain positions on the side rods. The hole *B* is drilled 3/8 in. and reamed for the 3/8 in. mandrel, which should turn freely in it.

The two nuts *M* and *N* are 3/8 in. hexagon nuts of standard dimensions. The indexing disc *O* is clamped between them, a washer *P* being provided between the two. The indexing disc, Fig. 12, is cut from some thin brass or iron. It should have as many notches in it as there are to be slots in the armature disc. A special indexing disc will have to be made for each special armature disc which is to be punched. Be very careful when locating these notches, as upon this depends the spacing of the slots in the completed armature discs. This completes the machine work on the laminae punch.

Drawing 1 shows how the punch is assembled. The indexing stop *Q* will have to be provided. This stop is made of a piece of brass spring wire bent to the shape shown and fastened down to the base on which the punch is mounted. It bears against the indexing disc, and the end falls into the notches in the disc. The disc can only rotate one way, since the stop can get out of the notch only on the side which slopes out to the periphery.

The size of the punch and the slot in the die-plate will depend upon the size of the slot to be punched. The die-plate *H* is to be made of annealed steel, which any dealer will provide, if told what it is to be used for. The slot-hole is drilled into the plate, and if the slot is to be rectangular should be filed to shape. An ordinary drilled hole will do for the round slots. The hole should taper out in all directions on the under side of the die-plate. A hole should be drilled in each end for screws which are to hold it to the punch frame. Having made the slot-hole, the die-plate should be tempered. To harden it, the steel should be heated to a bright red, and then dipped into oil or lukewarm water, but not cold water, for this would make it very brittle. Draw the temper in the flame of a Bunsen burner, wiping the steel frequently with an oily rag during the process. If the reader is not familiar with the hardening and tempering of tool steel, it would be better to have this done by someone having experience.

The punch *B* is also made of annealed tool steel. This should be bought in the most convenient shape, and machined to the proper dimensions. The one end is to fit in the hole in the end of the plunger, and the other is to make a very snug fit in the hole in the die-plate. The greatest care should be exercised in this



Drawing 2—Armature Punch Details

work to have all parts and dimensions

in it is placed over the mandrel on the

rod *R* used to turn the disc is inserted through the mandrel. The set-screws in the slide are loosened and the whole device is moved up to the proper distance for punching the slots in the disc, where it should be fastened by tightening the set-screws. The disc is rotated until the stop *Q* falls in one of the notches. Then turn a slight distance in the opposite direction until it is stopped by the projection on the indexing disc. Then push down the lever, forcing the punch through the lamination. Repeat this operation until all the slots are punched, when another disc should be placed on the mandrel.

Since most of the readers will not be able to design their armature cores, it seems to the writer that it would not be out of place to include in this article, some armature data.

The armature core consists of a number of discs of thin sheet steel of the best quality, known as laminae, each having a number of slots around its periphery to receive the winding. To prevent eddy currents' heating the core and causing a loss of energy, the laminae are insulated from one another by a coat of japan or enamel on one side of each sheet. The slots may be round or rectangular, as desired. The armature is slightly smaller in diameter than the bore of the field magnet. This allows of an air-gap between the pole faces of the field magnet and the armature core. This air-gap should be about 1/32 in. all around the core in small-sized armatures, and about 1/16 in. in the larger sizes, making the total air-gap from 1/16 to 1/8 in.

In designing the armature it is well to observe the following ratios of length to diameter: for two poles, the diameter of the armature should be about equal to the length; for four-pole fields, the diameter should be twice the length, and for six-pole fields three times the length.

on the shaft, between two heavy pieces of iron, and turn them down to the required diameter. The discs may then be removed and punched.

A very good material for armature construction is the ordinary black iron handled by all tin-shops, No. 27 to 29 being of about the right thickness. This will cost about 50 cents per sheet for a sheet 24 x 96 in.

This punch was designed to punch a slot having 1 in. perimeter in a No. 27 sheet, thickness 0.0172 in.; a slot having a perimeter of 1¼ in. in No. 28 and 29, 0.01565 in. and .01405 in. thick, respectively.

Tables 1 and 2 give data as to the number of slots for armatures of different diameters, and different slot dimensions. These are based on the density of magnetism in the air-gap at between 20,000 and 25,000 lines of force per square inch, which is usually allowed in small machines. The number of slots given should not be exceeded, as this would raise the density in the iron between the slots, which is already high, thus impairing the operation of the machine. If an odd number of slots is to be used, use one slot less than the number given in the table. In a two-pole machine the writer would advise the use of an odd number of slots.

TABLE 1

Armature Data—Using Round Slots

Core Dia.	1.75	2	2.5	3	3.5	4	4.5	5
Number of Slots								
¼ in. dia.	12	12	18					
5/16 in. dia.	10	12	16					
⅜ in. dia.			10	12	14	18	20	22
Shaft dia.	¼	7/16	½	⅝	⅝	¾	⅞	1

TABLE 2

Slots

THE INSTALLATION OF A SMALL ELECTRIC MOTOR

FREDERIC H. TAYLOR, ASSOC. M. INST. E.E. ASSOC. M. INST. M.E.

Everyone interested in model engineering who possesses a workshop, however modest it may be in point of size, soon feels the desirability of having power available for turning, drilling, shaping, etc. For the ordinary amateur, ½ to 1 h.p. will suffice for his requirements, and it is therefore a machine of about this size which will be considered in this article.

It might, perhaps, at first be asked if an electric motor is really the best form of prime mover for the amateur to adopt. If electric current is available from local mains, there can be but one answer—yes. Even if the current is sold at a fairly high price per kilowatt hour, it will still be well worth having, as the cost of working the motor will not be excessive, and the facilities and convenience gained, coupled with the safety, simplicity and reliability, render the electric motor a very good investment.

Points to consider before buying the Electric Motor.

(*a*) Whether the current available be "alternating" or "direct," and, if the former, whether single-, two- or three-phase.

(*b*) What is the voltage of the supply?

(*c*) In the case of the alternating supply, it will also be necessary to know the "periodicity" of the current.

Information on these points (*a*, *b* and *c*) can, of course, be obtained from the local

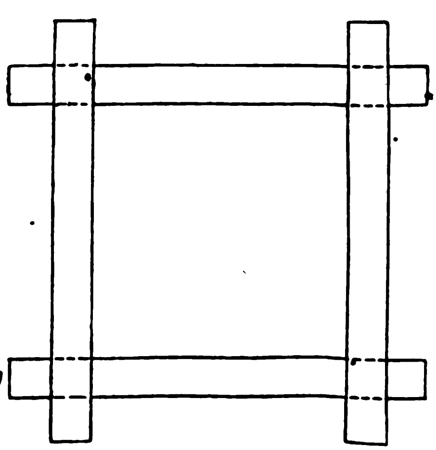
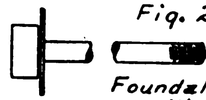


Fig. 1

Fig. 2.



Foundation bolt with plate

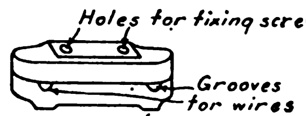


Fig. 3.
Double china 2-groove cleat

electric light company, who will also furnish particulars as to price, and will give the prospective customer the names of several firms which sell small motors.

In order to buy to the best advantage, it is best to accompany your enquiry with a brief specification showing what is wanted. It will then be found, if several prices are obtained, that they are comparable, as each dealer is presumably quoting on the same basis.

Specifications of D.C. Machine.—To be of — h.p., of the semi-enclosed type, and complete with cast-iron pulley of — in. diameter and — in. width of face, crowned. Also slide rails, tightening screws and holding down bolts. The machine to be capable of maintaining its full horse-power for not less than 5 hours continuously without undue heating or injury to any part, and to withstand an overload of 50 per cent. for one hour and 100 per cent. momentarily without injury of any kind. The motor to have been tested satisfactorily under load and for insulation resistance before leaving the factory. The manufacturer to supply with the motor a suitable starter, properly enclosed in a metallic case and fitted with a no-volt automatic release.

For ordinary machine tool work the motor should be shunt wound, since this class of machine runs at a practically constant speed under a varying load, provided the line voltage remains constant.

The Alternating Current Machine.—Where the supply is alternating, the purchaser must be careful to find out whether it is single-. two- or three-phase,

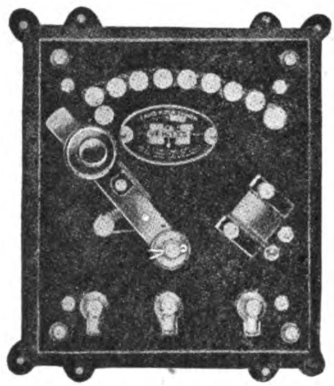


Fig. 4

and its periodicity. Two types of motor are available; namely, the "squirrel-cage or short-circuited rotor" and the "wound rotor or slip ring" type. For small powers up to, say, 3 h.p., the former is most suitable, being cheaper and more robust than the latter. As this type of motor is not adapted to starting under load, it should be provided with a double width pulley arranged to drive to a fast and loose line shaft, so that it may be run up to speed before the load is put on. The specifications for the A.C. motor will be similar to those for the D.C., but the following points must be remembered:

Speed.—The speed of any small motor is high; for a 1 h.p. machine from 1,400 to 1,500 revolutions per minute. The buyer will do well to take a motor of standard speed, and adapt the drive to the motor speed.

Most makers list and sell standard sizes of pulleys for their motors, and if these can be used, it is best to do so. For instance, a 1 h.p. D.C. motor would ordinarily have a pulley of size 3 x 2½ in. or 4 x 3 in.

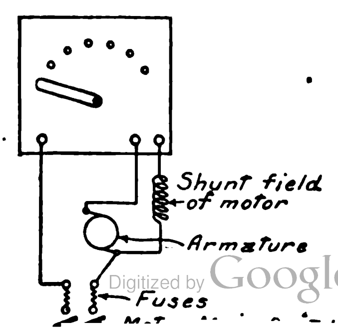
The semi-enclosed pattern is mentioned above. This is a good type to adopt in a very large number of cases, the open type being too liable to injury from dust, dirt, damp, or other causes. The totally enclosed type naturally has the additional advantage that it can be fixed in really bad positions. For this type one

machines, and prevent a lot of trouble which otherwise might occur because of a belt's becoming slack.

Motor manufacturers do not, as a rule, make the starters for their machines, but it is well to obtain this apparatus through the motor dealer, as he then takes the responsibility of the starter's being suitable for the machine. Many people do not employ a starter for very small motors. This, of course, means a saving in first cost, but is not necessarily the best thing to do. Starters vary considerably, the A.C. being quite different in design from the D.C.

Erecting.—The erecting of a small motor is a simple matter, but like other simple matters may readily cause a lot of trouble and *continual trouble*, if not properly done. In order to assist the amateur to avoid such trouble several different cases are considered.

(*a*) Assuming that the floor of the workshop is of the ordinary timber construction, the motor may be bolted down to the joists on which the boards are fixed, that is to say, the slide rails will be coach-screwed direct on these joists; ½ in. or, at the outside, ⅝ in. coach screws being amply sufficient for this purpose. If the floor is an old one, more or less rotten and generally irregular, as is often the case, in the only room the amateur can obtain, it is an advantage to first make a rectangular wooden frame, as shown in Fig. 1, out of deals, say, 3 x 6 in., and coach-screw this to the joists, the slide rails being coach-screwed down to the frame. This will enable



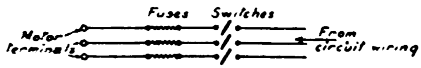


Fig. 6—Diagram of 3-Phase Connections. Squirrel-cage Motor

the motor to be mounted level, and will have the advantage of spreading the weight over a large portion of the floor. This method is also very useful where it is found that to get a convenient drive it is necessary to fix the slide rails parallel with the floor boards, and where the bolt-holes of the rails do not coincide with the distance apart of the joists. The underneath timbers *A*, *A* of the frame can, of course, be spaced to suit the joists.

(*b*) Assuming that the floor of the workshop is concreted, the cheapest and best way to go to work, is to cut out the holes in the concrete which will be required for the slide rails. These holes will be anything from about 8 in. to 12 in. deep, according to the length of the foundation bolt supplied by the makers. It is best to cut the holes, say, not less than 3 in. square, and somewhat larger towards the bottom. Usually the bolts provided are ordinary straight bolts with a loose plate at the bottom, as per Fig. 2. The bolts, with their plates fastened on, should first be dropped down into the holes; the rails will then be placed over them and the nuts loosely put on, to hold them in position. The motor can then be set on the rails and lined up with the pulley or shafting it is intended to drive. This having been done, the holes can be filled up with thin concrete (grouting). Ordinarily a week is sufficient time for the grouting to set hard. When this is done the nuts can be drawn up tight on the foundation bolts.

(*c*) A motor is sometimes placed on wall brackets, owing to lack of floor space. This method should only be adopted when absolutely necessary, as, naturally, it is always best to keep
chinery on the
th-

Wiring for and connecting up the Motor, etc. Voltage Arrangements.—As a general rule, the electric light company will provide current for a small motor, such as 1 h.p., at the ordinary voltage adopted for lighting. Larger sized machines commonly have to be supplied at the power voltage which is often double that adopted for lighting purposes. Where the electric light is already in the house, it is, of course, a great convenience to be able to adopt this voltage, as it simply means running a pair of wires to a local distributing board. If this board does not possess a spare "way" or circuit, it is best to take the new motor circuit direct from the bus bars of the distributing board, taking the precaution of inserting a pair of single-pole fuses in the wires as soon after leaving the board as possible. This will prevent the possibility of blowing the main or sub-main fuses, which supply the distributing board, should any mishap occur to the motor circuit. It will be best to provide for this purpose a pair of 10 ampere fuses for any size of motor up to 1 h.p.

The wiring may, of course, be done in several ways, each having its own merits, according to the conditions of the particular case. If the existing wiring is in wood casing, this system may well be extended, provided the room is thoroughly dry. On the other hand, if tube work has been used, this method of wiring had best be continued for the motor. For the amateur who has never installed any wiring work, ordinary wood or china cleats, which can be obtained very cheaply of any good electrical supply house, will save a lot of trouble and make a satisfactory job. Double cleats should preferably be used, as these keep the wires away from the wall. Fig. 3 illustrates the cleat suggested.

The wiring having now been carried up to the motor, a main switch and fuse for the motor, and in most cases a starter,

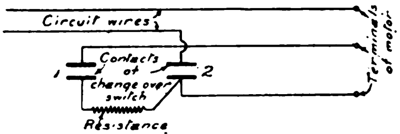


Fig. 8—Diagram of Connections for Single Phase Motor. Contact 1 is starting position, Contact 2 is running position and "Off" is midway position.

D.C. Motor Starter.—It might at first be asked why the motor should not be switched directly on the circuit. Certain small motors are so treated, but it is not really good practice. When a *D.C.* motor is starting from rest, it takes a much larger current than when running at a fair speed, and if it were switched directly on the circuit, without a graduated resistance being interposed, the initial current may be sufficiently great to either heat up the coils of the motor or cause the circuit fuse to blow. Besides, the sudden jerk given to the motor *and to the machine driven by it* is not good for either of them.

This device shown may be best described as an "automatic no-volt release starter." As will be seen from the illustration in Fig. 4, the apparatus mainly consists of a lever which is made to pass over a row of contact studs, which are connected to resistance coils contained in the starter. This lever carries at its end a soft-iron armature, which, when the lever has been brought to its final or running position, is attracted by and held to the iron core of a small electromagnet against the pull of a spiral spring fastened to the center of the lever. This electromagnet is in parallel with the line and is therefore always energized so long as electric current is available. Should the current on the line fail (no voltage being available), the electromagnet ceases to attract and the lever is thereby returned to the starting position by the pull of the spring, all the resistance being thus cut into the circuit again, and so protecting the motor from improper starting.

The ordinary starter for a D.C. shunt motor commonly has three terminals, which are marked respectively *A*, *F* and *L*, meaning, of course, armature, field and line. The connections for such a case are as per sketch, Fig. 5. In this sketch a D.P. switch and pair of S.P. fuses are shown in the circuits.

These starters are sometimes fitted with an automatic overload release, which comes into operation as soon as a dangerous overload comes on the motor. The writer would, however, prefer to rely on the reasonable conduct of the user and on the protection afforded by the fuses, rather than install the "overload release" on the starter.

A.C. Motor Starting.—The A.C. motor is usually "polyphase," that is, either two- or three-phase. For small power installations, such as are being considered in this article, "squirrel-cage" or "short-circuited rotor" machines are almost invariably used. These are more simple to start up than a D.C. machine, as no special starter is required. Consequently the motor (either two- or three-phase) can be switched directly on the line. The sketches, Figs. 6 and 7, show the connections in diagram form. In either case the switches used must be linked together, so as to make or break the circuit on each conductor simultaneously.

This is quite imperative and is a very simple matter. Ordinarily, "tumbler" switches may be used, and these (either three in the case of three-phase or four in the case of two-phase) may be mounted together on one common base block and coupled together in the usual way by means of a hardwood handle-bar, as is done in the double-pole tumbler switches used for lighting work. Fuses are shown in the diagrams between the switches and the motor.

The starting up of a single-phase motor is, electrically speaking, not quite so simple. Usually this machine has two windings on its "stator," one being the "starting" coils and the other the running coils. The starting switch will therefore be a change-over switch, having three positions, namely: "starting," "running," and "off," the last being the mid-position. The arrangements vary, but Fig. 8 is a fairly typical diagram of connections.

Directions of Running of the Motor.—It is possible that when the motor is set up in position, it is found that the direction of rotation is wrong. This is quite easily altered. If a D.C. machine, it is simply necessary to change the direction of the current in the armature or the field, *not* both. If A.C., simply change over the leads in *one* phase.—*Model Engineer and Electrician.*

WOODWORKER

NOVEL WRITING-TABLE AND BOOK-CASE

HENRY JARVIS

The table, shown in Fig. 1, will be found a very suitable article for the amateur carpenter or cabinet-maker to construct, and a very useful piece of furniture when finished. I say suitable to make, because there are no complications of any kind, no mortises or tenons, and very little gluing.

Before beginning the actual making, the front and end elevations, Figs. 2 and 3, should be well studied, and when the details are mastered, the materials can be cut out, according to the specifications given below, and all of the pieces "planed up" true as regards width and thickness.

One-half of the framing is shown in Fig. 4, from which it may be seen that the legs are formed in skeleton; that is, the two pieces of which each leg is made are fixed together at right angles, the joint being tongued.

The legs and also the upright bars are let into the shelves and top, to the extent of half of their respective thickness, thus the shelves and the top have to be cut away as Fig. 5. If these are all fastened together and cut at one time, they will be all alike, and the bars will fit properly.

The top, *A*, runs over the whole article, and as a matter of strength the grain should run lengthways. This will then secure the two side frames firmly together, as far as the upper part is concerned.

The four laths which come towards the center of the table, *B*, must be rabbeted on the inside to take the board *C*, which forms the back of the book-shelves, and these two boards (the grain must run vertically) in turn must be trenched to take the board *D*, which forms the bottom of the drawer case. This board is fixed in the trenches, by screwing through, from the inside of the book-case *E* at each side, and particular care is necessary in getting this of the right length, or the two parts of the framing will not be parallel.

The bars should be a tight fit in the notches made to take them in the shelves and top, the latter clipping them as in the vertical section, Fig. 6. They may be glued in, but they will require nailing or screwing, and I recommend the latter, using brass screws, and sinking the heads exactly level with the wood. One screw should be inserted through each part of the legs and the bars *B*, with each shelf

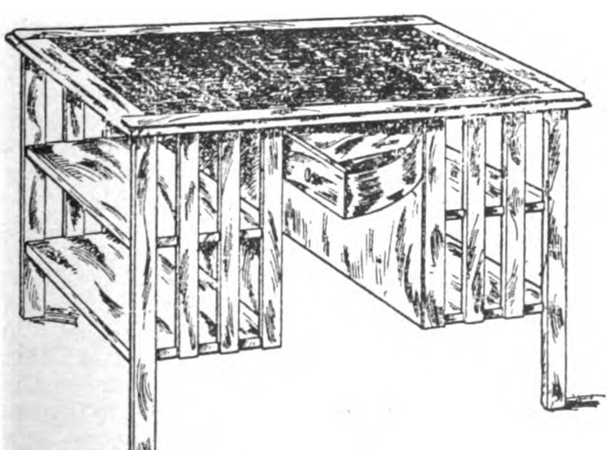


Fig. 1—The Completed Writing-Table and Book-Case

and the top, and two through the other bars. If spaced evenly the screws are more ornamental than otherwise. The top *A* is only for the purpose of fixing the parts together, and is covered by the real top, therefore there is no need for it to be of hard wood throughout. The outside edges and ends must be of the same kind of wood that the table is made of, but the inner part (shown grained in Fig. 4) may be of pine or American whitewood. The top proper should be framed up as Fig. 7, the outside rim projecting slightly above the center panel and rather more below it, as in Fig. 8. This method of forming the top makes it convenient for attaching a piece of leather or cloth to the top for writing purposes, *F*, Fig. 8, and also allows the top to clip the framing, thus adding to the strength of the whole. It must be understood that the latter makes it necessary for us to have the framing of the top the same width as the projections at ends and sides over the framing, that is, 1½ in. and 2 in. respectively; or perhaps it is better to say that the center panel must be exactly the same size as the framing of the table.

The top is easily secured by screwing up from underneath through the top *A*.

We now come to the drawers, which are two in number, one on each side of the table, and as shown in Fig. 9. They are made in a novel manner. The actual making need not cause anyone the least misgiving, as it is not so difficult as it looks. The square corner of each drawer should be lapped dovetailed in the ordinary way, Fig. 10. The other ends of the fronts can be cut away, leaving the lap on the outside, so that the curved part can be screwed into it, and it is also fixed in the same way to the drawer side.

The curved part may be formed by two or more pieces of three-ply wood, bent round a block cut to the right shape. If glued together and kept under pressure until the glue is dry, they will permanently keep their shape.

As these curved parts form the back of the drawer, they must be kept ½ in. less in width than the front and side, so that the bottom will nail on. They will, of course, fit in grooves in the other parts in the regulation manner.

As may be imagined, these drawers do not slide in the ordinary way, but are hinged at the corners, *H*. This may be done with pivots passing down through *A*, and up through *D* into the fronts; but the better way is to hinge them to the bars *B*, using a single hinge the full depth of the drawer front. When the drawers are finished and in position, small blocks should be glued to the under side of *A*, in about the position shown at *I*, Fig. 9. These will prevent the drawers from opening completely out and straining the hinges.

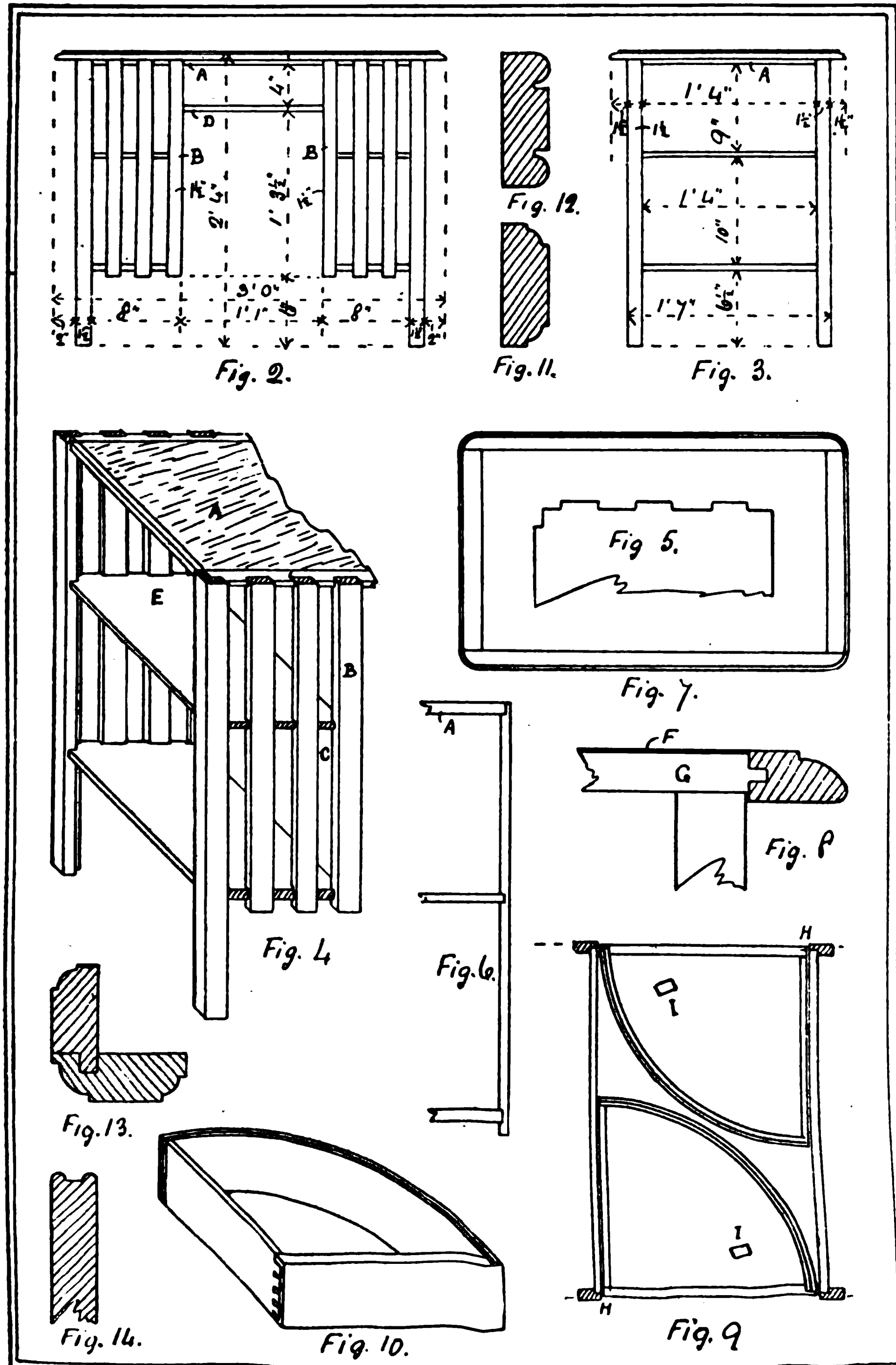
I give in Figs. 11 and 12 alternative suggestions for moulding the vertical bars, and in Figs. 13 and 14, sections of the leg and sections of the edge of the shelves moulded.

SPECIFICATIONS OF THE NECESSARY MATERIAL

8 pcs. 2 ft. 4 in. long, 1½ x ½ in. (legs)
12 pcs., 1 ft. 9 in. long, 1½ x ½ in. (bars)
2 pcs., 1 ft. 7 in. long, 9 x ½ in. (top shelves.)
2 pcs., 1 ft. 7 in. long, 9 x ⅝ in. (bottom shelves)
1 pc., 2 ft. 9 in. long, 19 x ½ in. (top *A*)
1 pc., 1 ft. 2 in. long, 19 x ½ in. (*D*)
1 pc., 2 ft. 9 in. long, 20 x ¾ in. (top panel)
2 pcs., 3 ft. 1 in. long, 1½ x ⅞ in. (top framing)
2 pcs., 1 ft. 11 in. long, 2 x ⅞ in. (top framing)
2 pcs., 1 ft. 1½ in. long, 4 x ⅞ in. (drawer fronts)
2 pcs., 1 ft. long, 4 x ⅝ in. (drawer sides)

About 4 sq. ft. of 3-ply wood (drawer backs and bottoms), hinges and brass screws as required.—*Hobbies.*

In Germany the railroads furnish excellent facilities for transporting invalids and cripples. A first-class car is provided for those who can afford to pay the rate. This car is fitted with every convenience. A special apartment opens on the level of the station platform with a double door which enables a stretcher to be carried in without the least difficulty. In the remainder of the car there is a kitchen where meals can be prepared, and in the rear a beautifully upholstered section for the family or friends. For invalids who travel second class or third class there is an apartment on an ordinary car which opens to the platform by means of a double door. A special rate, of course, is charged for the extra convenience.



Novel Writing-Table and Book-Case

Fig. 2.—Front elevation of table. Fig. 3.—End elevation of table. Fig. 4.—Isometrical sketch of half framing. Fig. 5.—End of shelf cut to take bars and legs. Fig. 6.—Vertical section showing

HOW TO LINE A LATHE

D. L. KELLY

First, fasten a piece of straight pipe in the chuck, with one of its ends nearly flush with the face of the chuck. Then plug this end of the pipe with wood, revolve lathe-spindle, and with a pencil find center. Insert a fine sewing-needle, with pliers, and true carefully.

Take center and key out of tailstock-spindle, paste a piece of smooth paper over end of same, find center of spindle on paper and draw vertical line 0.0′, Fig. 1, through center. Bring tailstock-spindle close to needle point, and adjust screws in tailstock-block till needle and line 0.0′ coincide. Clamp, with needle revolving, pierce hole *A*, about ten-one-thousandths inch in diameter. Turn spindle half a turn, and if needle enters same hole again, headstock and tailstock are at the same height.

Run out tailstock spindle till the distance from point of spindle to end of tail-block equals length of base of same. Bring tailstock close to needle and clamp. Pierce the hole 1. Give spindle a half-turn and pierce the hole 2. Using a magnifying-glass, measure the distance between holes 1 and 2. Call it 1/64 in., and the needle is in hole 2, the tailstock is high at back. File and scrape V's of

Fig 1

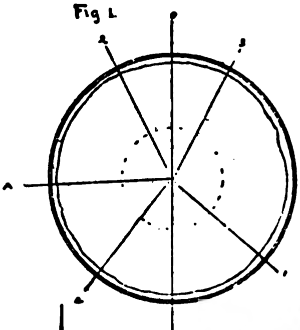


Fig 2

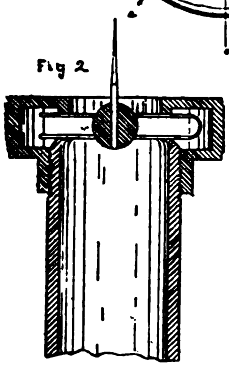
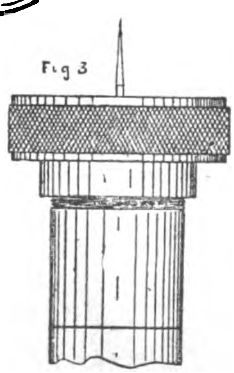


Fig 3



block till needle enters hole *A*, then the tailstock-spindle is parallel to bed.

To test headstock, release pipe and draw out till the distance from needle-point to end of headstock base equals length of same. True needle and proceed as before, pierce holes 3 and 4, and if needle is in hole 4, the headstock is high at back, and the amounts will be one-half of either the vertical or transverse distance between the holes. File and scrape accordingly till needle enters hole *A* correctly in all positions.

The carriage is on separate V's, and is tested in the same manner; clamp a jig-bush in toolpost, and get another to fit inside, center correctly, paste the paper on the inner bush, and proceed as before. If the lathe has a cross slide in carriage, it may be tested with a jack on faceplate, in the usual way. The sag of needle, when pipe is out far enough to multiply the actual distance four times, may be found by reversing the operation. After the tailstock is lined correctly, put a drill-chuck on tailstock-spindle, and mount the same length as used. Put a piece of wood with a hole in center of lathe-chuck, paste paper over hole, draw vertical line through center, true needle, and pierce hole; half turn lathe-spindle and pierce again; half the distance between holes is the sag.

I have found it difficult to true the needle correctly when mounted in wood. A needle-holder that will facilitate that operation is shown in Fig. 2, and consists of a pipe threaded at end and spun inwardly, a cap to fit pipe, double disc connected at side, ball with needle placed between disc; when not in use turn needle inward to protect point. The needle is marked at three places where the diameter is 5, 10, 15 thousands. To mark these, copper needle and open micrometer to 15 thousands, take needle between finger and thumb, twist it between points; it will leave a bright ring.

If a hole is pierced 15-thousandths diameter, and if you move the piece over till the needle touches one side of that hole at the 10-thousand mark, then the piece has been moved 2½ thousands and at intermediate points accordingly.—*Buffalo Item*.

AN AMATEUR'S VISE BENCH

W. F. MANLEY

The chief requirement of a vise bench is stiffness and freedom from vibration. The details of construction depend somewhat on the circumstances attending each individual worker, as the height of the user must be taken into consideration, so as to obtain the best results with the least amount of labor. The top of the vise should be about level with the elbow when standing ready for work. This height will be found to vary between 40 in. and 44 in. from the floor, so the writer is taking 42 in. as an average, allowing 4 in. for the height of the vise itself; the top of the bench proper may be 38 in. from the floor.

If there is no difficulty in knocking a couple of holes in the workshop wall, and if there is a brick or concrete floor, the method shown in Fig. 1 will be found a very strong one. The uprights and cross-pieces in all cases will be 3 x 2 in., and the bench top 1 in. or 1¼ in. material. For the bench shown, two holes should be made in the wall about 6 in. deep x 4 x 6 in. in cross-section, and centers 1 ft. 10 in. apart horizontally, also two holes of the same size in the floor, and the same distance apart, and centers 1 ft. 4½ in. from the wall outwards. Cut two pieces of the 3 x 2 in., 3 ft. 5 in. long, and two pieces 1 ft. 10 in. long, at one end of each piece, making the halved joint, Fig. 6, and bolt up with a couple of ¼ in. bolts in each. In the ends that are to be cemented into the wall and floor put in five or six strong cut nails, with their heads projecting about 1 in. Stand the supports in position, and level them up, and carefully fill up the holes with cement with a few small pieces of stone about the size of a nut mixed in. Leave a couple of days to set before putting the bench top on. This may be made of two 9-in. widths

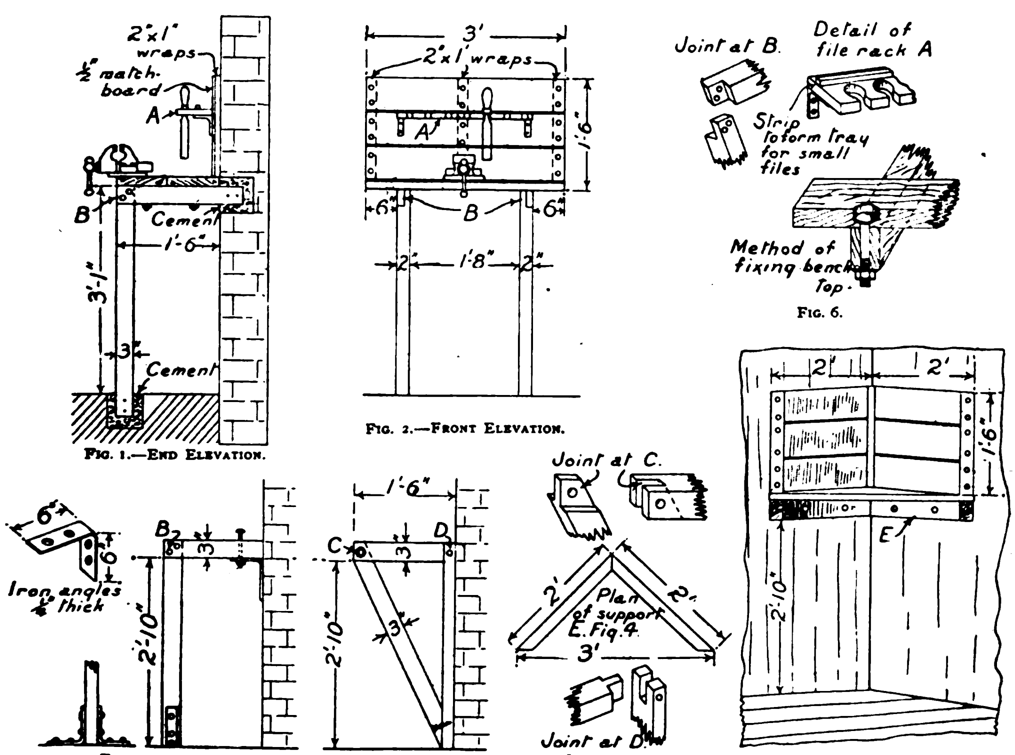


Fig. 1.—End Elevation.

Fig. 2.—Front Elevation.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

How to Construct an Amateur's Vise Bench

bolted to the crosspieces by 3/8 in. bolts, as shown. The vise may be bolted wherever desirable.

The toolboard at back is made of 1/2 in. matchboard 6 in. wide, screwed to three pieces of 2 x 1 x 18 in. long. The latter are first attached to the wall by cut nails, and carefully lined up level. The rack for files is to be made of 1-in. material, and of any convenient width and length. The straight slots are cut wide enough for the tangs of the files only to pass through, and the circular parts slightly larger than the ferrules. The rack is secured to toolboard by iron brackets.

Where the above method cannot be followed, the uprights can be fixed by strong iron brackets, as shown in Fig. 3, or made after the style of a bracket table, as in Fig. 4. A corner of the workshop may be used, if found more convenient, and in this case the construction is simpler and, as shown in Fig. 5, measurements for the last three methods of construction are left for the maker to work out, as much depends on the space and position at the disposal of each individual user. The elevations for supports in Figs. 3 and 4 only, are given; the distance apart and other measurements are as in Figs. 1 and 2. Sketches of joints, etc., are not to scale.—*The Model Engineer.*

ELECTRICITY IN THE PLATING ROOM*

S. E. HUNERFAUTH

The subject of electricity in the plating room is a very important one. In the earlier days before the introduction of dynamos, batteries were used to supply the currents. These were very satisfactory except for the expense of maintaining same, and the limited amount of current which was available. At this point I wish to say that the current given off by the battery is the most direct or continuous current to be had. The first dynamo to be used for electroplating was invented in the year 1842 by J. S. Woolrich. This was what is known as a "magneto-electric" machine. Mr. Wild, however, was the first to construct a dynamo which was really suitable for the purpose. He invented a large dynamo with field magnets that were separately excited from the small magneto machine. His first machine was used for many years by Messrs. Elkington. It was necessary to keep the armature in this machine cool by means of a stream of water circulating through it.

About the year 1867 Mr. Wild introduced a multipolar dynamo with a redressing commutator. Weston introduced a small machine for electroplating which had steel cores on it, with the main circuit around them, and supplied with an automatic cut-off to break the current and prevent the magnetism from reversing by back current from the tanks. Gramme, in 1873, built a special form of dynamo with armature wound with strips or bar wound, having commutators at each end, with an output of 1,500 amperes at 8 volts. Siemens and Halske were early in the field with machines having bar winding. Brush also constructed machines of low resistance, giving a voltage from 3.3 to 4.1 volts. Thus, we have a brief history of plating dynamos. From about the year of 1880 there were numerous types and makes of dynamos in use. We will now take up the different types of dynamos.

VARIETY OF DYNAMOS

First, we have the magneto dynamo, which was constructed with the regular armature, but the field magnets or the poles were permanent magnets, having no coils on the poles. The objectionable features of this dynamo were that the voltage was not regular, there being quite a drop in the same from no load to full load of the dynamo.

Second, we have the shunt-wound dynamo—self-exciting. This type of dynamo was in use for a great many years, and there are some in use to this day; in fact, there was one concern that continued to build them up to a few years ago. In fact, the shunt-wound dynamo was a great improvement over the magneto, and also over the series-wound dynamo. The greatest objection to a

* Paper read before the Chicago Branch of the National Electro-Platers' Association.

shunt-wound self-exciting dynamo is that the voltage is not constant at the different loads. Thus, to do plating and have a nearly constant voltage it was necessary for the operator to change the field rheostat or shift the brush-rocker every time he changed the load in his tanks to keep a nearly constant voltage.

Third, we have the compound-wound dynamo. This is a combination of the old series dynamo and the shunt-wound dynamo. The compound-wound dynamo has two sets of coils on the poles, one called the shunt coil, which is used to excite the dynamo, and which takes only a small fraction of the current generated by the armature. The series coils circuit with the armature, and by the aid of the compound or series coils we are enabled to hold the voltage constant regardless of the load in the tank. Thus, you will readily see that when the operator sets the voltage of the dynamo, it is then self-regulating. It is not necessary to keep shifting the rheostat at every change of load; in fact, any good compound-wound dynamo should hold its voltage constant, whether you are using 5 amperes or a full load of the dynamo, thereby enabling the plater to do more and better work with a uniform deposit than with dynamos not containing these characteristics. It is now possible to build low voltage dynamos having all the characteristics of modern power dynamos, including self-regulating brushes, compound-winding and all of the other features contained in power generators.

Fourth, we have the shunt-wound separately excited dynamo, and in the writer's opinion this is the ideal plating dynamo, whether small or large, and especially in large dynamos. The separately excited dynamo has its fields excited from an external source, either from the power or lighting circuit in the building or from a small exciter. This type of dynamo has practically the same characteristics as the compound-wound dynamo, for the reason it will hold its voltage nearly constant, from no load to full load graduation in adjusting the voltage, and cool operation.

GOOD DYNAMO AN ESSENTIAL

Thus, you can see it is very important to have a good dynamo to do good plating. But the fault does not always lie in the dynamo for poor work and insufficient amount turned out for a day's work. At this time the writer wishes to say that he has visited a great many plating rooms and has often found that the dynamo and the conductors from dynamo to tank receive very little care. It is very often a fact that the plating room may be equipped with a good dynamo, but the results obtained in the plating are very unsatisfactory. It is very often a fact that the conductors are of insufficient size and are very poorly erected. Connections are very poor, badly corroded, and, in fact, are sometimes very loose and produce considerable heating at that point. This not only causes a waste in current, but also a loss in voltage and an insufficient amount of work which the plater is able to turn out. As an example, the writer was once told by one of the largest stove manufacturers that he did not know what the matter was with their plating room—that it was taking from 45 minutes to an hour to turn out a batch of work, whereas they formerly did it in 25 minutes. I made an investigation and found the copper conductors from the dynamo to the tanks were insufficient. The joints were bad; in fact, badly corroded. The dynamo was of ample size. I doubled the size of the conductors, soldered all the connections and joints; the results were, he later said, that he was turning out double the amount of work that he did before. This is true not only in this case, but the same is also true in a great many plating rooms now operating under similar conditions. Too much care and pains cannot be taken in installing the dynamo and conductors in the plating room.

AN IDEAL PLATING ROOM

The writer had the pleasure recently

If the same care were exercised in erecting the dynamo and appliances connected therewith as in making up the different solutions, you would have much better results than you would have at the present. This is not given in the sense of criticism, but in the spirit that it may be of some benefit to you.

Next, we will take up rheostats and their use in connection with plating solutions. Nearly every plater of today uses a rheostat in connection with the tank that he has in the plating room. Rheostats are essential where you operate one or more solutions from the same dynamo. It is very often necessary to reduce the voltage in a tank lower than you can or dare to do on the dynamo for the reason that it will interfere with the other tanks; therefore, it is necessary to provide each tank with a rheostat, but rheostats are often condemned for the reason that they are often ordered by the number of square feet or amperes required. To make this clear, *A* might have a tank containing 400 gallons of solution for his work and a 300-ampere rheostat might be the proper size, while *B* might have 400 gallons of solution, but different kind of work, and a 400-ampere rheostat would be suitable for his tank. The size of the rheostat depends upon the average number of square feet of work you have in the tank and the kind of solution. If you can give this information to your dealer, he can generally give you just the size rheostat required for your work. Do not condemn a rheostat if it does not cut down the voltage to the point to which you would like to have it or if the wires get hot. It is not always the fault of the rheostat, but simply because you have not the size rheostat required for your work. The drop of voltage across the rheostat depends upon the amount of current you are using.

VOLT-METERS

This is an instrument that is almost impossible to dispense with. You would not think of operating a steam boiler without a steam gauge. Then, how can you expect to operate your plant without a volt-meter unless you simply guess at the voltage in your tanks and turn out your work accordingly? Every modern and up-to-date plating plant is equipped with a volt-meter, which enables the operator not only to read the voltage of his dynamo, but of each tank independently. Still, there are a number of plants operated today without a volt-meter, and are operated simply by guess. Ammeters are used for measuring the current, either in a tank or for the entire output of the dynamo. While it is possible to operate a plating room without an ammeter, still, they are useful in determining the amount of current you are consuming in turning out your work. —*Keystone.*

A Movement in Silver

Silver is now selling at the highest price reported since 1907, the recent advances having been due in part to speculative activity, and in part to an actual demand for the metal from India, and to the probable increase in the demand for China, says the *Engineering and Mining Journal.* The speculative activity has been based largely on the belief that the Indian government would soon be obliged to buy largely for coinage purposes, the reserve of silver rupees having been drawn down to a point which seemed low in view of the probable demand for money to pay for the good crops of the present year. This anticipation has proved to be correct, but the result has not been altogether pleasing to the powerful group of eastern speculators which has been carrying heavy stocks of silver in London and in India for some time. It now appears that the Indian government, with unusual shrewdness, had been anticipating its needs and had been buying silver quietly on the open market for some time. There were some suspicions as to its action, but the fact was not fully known or accepted until a short time ago, when the steamers to Bombay and Calcutta carried out shipments amounting to £750,000—about 6,050,000 ounces—on government account. It is understood in London also that further large shipments will be made soon. This movement has caused some surprise, but it has entirely frustrated an attempt by the Indian speculators to corner the market.

Your time belongs to your employer when he pays you for your work; then to "kill time" is *robbery.*

AN AUTOMATIC SECTION WINDER

JESSE O. FISHER

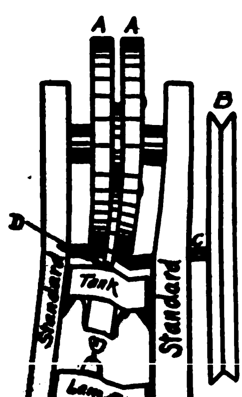
I have read several articles in different magazines describing section winders, but as yet have failed to find any that would paraffin the wire, either as it was wound on the coil or wound in the section. I have, therefore, designed one, and I think that it will give satisfaction in most cases, or at least suggest a good plan.

In Fig. 1 is shown the completed machine. It is designed to operate by a small battery motor. The motor drives the paraffin wheel *D*, which by friction drives the section. By use of the friction drive there is enough power delivered to the section to keep the wire tight, yet the tension is not sufficient to break it. The machine can also be constructed to wind quite a number of different sized sections by using different forms in winding.

You will need to determine the dimensions of the machine from the diameter and thickness of the sections to be wound.

To construct this machine, we will begin with the base. All wooden parts should be made of some hard wood, such as maple, oak or mahogany. The base should be heavy and of ample size to balance the machine well. Two mortises are made in the base to fit the projections on the standards, shown at *H*, Fig. 3. The edges may be beveled to add to the appearance.

The standards, Fig. 3, need not be quite so heavy as is the base, but should



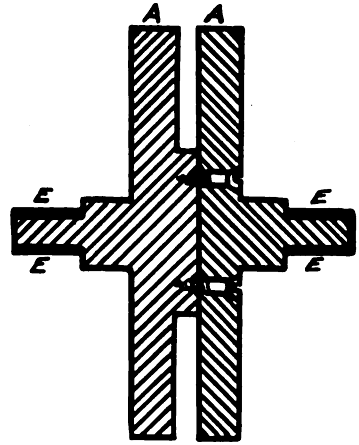


Fig. 2—Cross-section of a Form

be at least 3/8 in. thick. A slot *F* is accurately cut in the top of each standard, and the edges are made smooth. The shaft *E* turns in this slot and should be made a snug fit, but still free to move up and down. A small bearing *G* is provided for the main shaft, and to this shaft are fastened the pulley and paraffin wheel. It will add greatly to the easy running of the device if the two bearings are fitted with brass bushing. On the inside of each standard are fastened, by means of screws, cleats which support the paraffin tank. The projection *H*, Fig. 3, which is on each of the standards, is so cut as to fit tightly in the mortises which are in the base, and the standards are glued firmly in place.

The paraffin tank is made of galvanized iron. If you are not an experienced tinner and have not the proper tools, you had better have the tank made by a tinner. There must be no soldered joints in the lower part, as the heat from the lamp would, of course, melt the solder. The advantage of having the tank in the shape shown is to give it a large capacity and allow the wheel to gather nearly all of the paraffin.

The paraffin wheel is the same width as is the section to be wound. It should be turned true in a lathe and rigidly fastened to the main shaft. A strip of

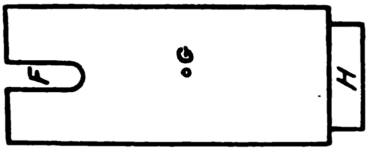


Fig. 3—Standard

The pulley is also turned and is fastened to the same shaft as is the paraffin wheel. The pulley should have such a diameter as will allow the motor to run at its proper speed.

A cross-section of the form on which the section is to be wound is shown in Fig. 2. At first, it is turned to the proper shape in a lathe, from a solid block of hard wood. The slot is made the width of the section plus the width of the saw-cut, in order that when the block is cut in two, the slot will be the proper size. Before the block is cut, insert two screws as shown in Fig. 2, then withdraw them and cut the block as shown. If the work is not done in this manner, it will be found difficult to center the two blocks and put the screws in the proper place. On each end a brass tube is placed over the wooden bearing. This is shown by *EE*, Fig. 2. This tubing should be of a size to fit and yet turn freely in the slot *F*, Fig. 3. Any number of these section-forms may be made, each of a different size. If the thickness of the section is changed, the paraffin wheel will also have to be changed. Any small lamp may be used as a heater, but I would suggest an alcohol lamp or a small gas lamp, as the fumes from coal oil are objectionable.

Fill the tank with paraffin (this should be done first, in order to allow the paraffin time to melt, while you are getting the other things ready.) Belt the motor to the winder and pass the wire which is to be wound through a small hole in the side of the form, similar to those holes which are on all spools of wire. The switch to the motor should be placed where it can easily be reached. When winding a section hold the wire between the thumb and forefinger, and guide it on smoothly and closely; the machine will do the rest. To remove the section remove the screws and separate the form.

THE DEPOSITION OF NICKEL ON NICKEL

EMMANUEL BLASSETT, JR.

A correct method of renickeling work has never been described in any of the text-books on plating, and the opinion prevails among many platers that it is impossible to plate nickel on nickel so that it will adhere in a perfect manner. Occasionally this statement appears in print and the self-styled experts maintain that it is impossible to deposit an adherent coating of nickel on nickel. They are responsible for spreading considerable misinformation, and it is with the hope of imparting correct instruction on the subject that this article is written. After so many years of progress in all branches of electro-deposition, it would be a sad reflection on the ability of the American plater if he were unable to deposit nickel on nickel as readily as on steel or brass, and with the same good results.

The deposition of nickel on nickel is not a difficult matter when the proper required to be refinished without removing the previous deposit of nickel may be replated without danger of peeling, and the deposit may be made to adhere as perfectly as the original coating.

The method to be followed in cleaning nickeled work for plating is to remove the buffing composition and grease, as far as possible, by running the work through an electric cleaner or a potash solution. The work is then preferably run through a hot muriatic pickle and again put through the potash. The work should then receive a very slight coating of copper, just enough to cover it, then be rinsed in water and put through the following dip:

Sulphuric acid . . . . 5 parts
Nitric acid . . . . 1 part

This dip is used cold and as little water as possible should be allowed to enter when running work through it. It will be found that this dip will remove the

minute to remove the copper, and the work should never be allowed to remain in it longer than is necessary to remove the copper deposit. When the work is removed from the dip it is rinsed in water and given a final deposit of copper, and after again rinsing it is immediately transferred to the nickel bath. By following the operations described the second coating of nickel will adhere perfectly, and it will stand bending, and filing, or any other mechanical operation that it may require. It will adhere as well as the original deposit.

On first-class work where a close inspection of the deposit is made, there will frequently be found pieces that are cut through, owing to the carelessness of the buffer, or the difficult nature of the work to be buffed, or possibly on account of the deposit's being too light. The expense of removing the nickel by stripping and polishing from work that is cut through is considerable, and by such a method the work is generally refinished at a loss to the manufacturer. Stripping and repolishing is too expensive and unnecessary, and all such work may be refinished as described in this article. Job shops frequently receive work to be refinished with the nickel worn off a little, on the edges, such, for example, as stove trimmings. Such work may be refinished by brightening the deposit on a buff wheel and smoothing down the spots that are cut through with tripoli. This is the most economical way, to say nothing of the desirability of having two coats of nickel on the article instead of one. A deposit of nickel on nickel, on such work as stove trimmings, may be made to adhere sufficiently well, by brushing the surface with slacked lime and copper-plating lightly previous to nickeling. On all large pieces that do not require a severe test it is unnecessary to use the dip described in this article. The dip should be used on all small work where brushing is too expensive or difficult and a perfectly adherent deposit is required.

Nickel may be deposited on nickel successfully without copper-plating, and the method subsequently described may carbon anodes. This dip is made as follows:

Muriatic acid .... 10 parts.
Water .... 2 parts.

This dip may be used cold, but usually better and quicker results are obtained if it is heated to about 100 degrees F. The work to be replated should be attached to the cathode rod for a few seconds only, immediately rinsed in clean water and transferred to the nickel bath. It is not necessary to use the dip previously described in connection with this method, although it may be used, if desired, to ensure against failure. The work should be chemically clean previous to treatment in the muriatic acid solution. Four to six volts are used in working this solution. In conclusion it may be stated that nickel may be deposited on nickel, with little danger of peeling, by removing the grease in a potash solution and vigorously brushing with pumice stone. The objection to this method is that pumice stone scratches the nickel, and the finished article, when buffed, would be covered with scratches. It is also expensive and difficult to brush certain classes of work. The point to remember in renickeling work is that the surface should be acted upon very slightly by a dip such as described in this article, when a perfectly adherent deposit will be produced. —*The Metal Industry*.

A company of young electrical engineers in England have invented a device to indicate the approach of another vessel and thus prevent collisions at sea. The invention consists of a large drum 9 ft. in diameter, which is swung aloft away from possible interference from deck sounds. It is provided with sixteen receiving mouths which receive all sound waves. At the bases of these receivers contact breakers are fixed which are sensitive to general sound waves, but stable to mechanical vibrations. Each of these receivers receives the sound from a particular direction. The contact breakers are connected electrically to

THE FIRST WIRELESS TIME SIGNAL

Captain J. L. Jayne, United States Navy, Superintendent United States Naval Observatory, Washington, D.C., writes:

"I notice in your number for August, 1912, in an article entitled 'The First Wireless Time Signal,' that the claim is set forth that the first time signal was sent from the Marconi station, from Camperdown, Nova Scotia, in 1907. As a matter of fact, the United States Navy anticipated this by over two years. The fact that arrangements for such signals were being made was announced in the 'Notices to Mariners,' published by the Hydrographic office in November, 1904, and signals were actually sent out in January, 1905. The navy has been regularly sending out radio time signals from some of its coast stations since that date. It is possible that our work suggested the idea to our northern neighbors. I hope you will correct the impression that the Camperdown station got ahead of us. The facts that I have given above are matters of record in the Navy Department.

"I read with pleasure the resolution of congratulation passed by the Jewelers' Association. I note, however, that the resolution spoke of the 'New Enterprise.' As a matter of fact it is only new in that the station is new and powerful and possibly some other details.

"It is now expected that a radio (wireless) time signal will be sent out from the new station at Arlington at noon each day in exactly the same way as to grouping of sounds as those being sent out at present over the Western Union wires. It is probable, however, that a similar signal may also be sent out at night, on account of the fact that signals carry farther at that time. No decision has yet been made as to this point."

The articles on wireless in the *American Jeweler* during the last six months, and in connection with the subject which are yet to be solved. It is not known what wave-length will be most effective at the wireless station. Furthermore, it is not certain just how far over the Alleghany Mountains the new station will be able to reach. It is expected that the flashes from Ft. Meyer will go 3,000 miles out to sea; but whether they will reach more than 1,500 miles to the west, or even that far, is yet to be shown. Therefore jewelers are warned not to purchase apparatus which may prove useless to them unless it can be tuned to the proper wave-lengths.

Synchronization of the railroad, postoffice and other public clocks throughout Germany by wireless telegraphy is also under way in Germany. This does not mean that the clocks are automatically synchronized, like a self-winding clock wired in the Western Union system in this country, but merely that wireless time signals will be sent out by the German imperial postoffice from the tower now being constructed at the town of Fulda. This tower will be over 300 ft. high, and the signals will be sent once each minute by a master clock closing the circuit of the radio transmitter.

The London City Council has ordered that all public clocks must be synchronized, or in other words must be so regulated as to be within a reasonable distance of Greenwich time. For a number of years past it has been a standard subject of sport with the daily papers in London to make fun of the clocks. Recently one of the daily papers took a census of the public clocks in London with the result of showing a variation of 21 minutes, the clocks giving actual time being just over 3½ per cent. of the total and on no street could more than two clocks be found to coincide. The difficulty has been owing chiefly to care-

THE MARCONI VALVE DETECTOR

CHAS. H. COLLINS, JR.

The Marconi valve or "lamp" detector is rapidly coming into favor with the wireless experimenters of America. The adoption of this instrument in preference to its liquid and crystal brothers is probably due to the fact that the valve requires no minute adjustment, which is so bothersome when using the crystal and liquid rectifiers. Furthermore, the valve is unaffected by close proximity to powerful radiating stations, a fact alone which would make the valve a favorite of the experimenters.

The Marconi valve was not invented by Marconi, as the name might imply, but it is a product of the fertile brain of England's foremost expert, Dr. Fleming. Fleming invented the valve in 1904, and several years later DeForest patented an instrument which he called an audion, but which in reality was nothing but a form of Fleming's valve.

When first used, the valve consisted of an ordinary small incandescent lamp, with a small metal plate suspended directly above but not touching the carbon filament of lamp. In present-day practice the carbon filament has been replaced by tantulum or other equally refractory metals which are supplanting carbon in the present-day construction of filaments. In many cases the metal plate has been replaced with a metal grid. The grid, or plate, outside connection consists of a platinum wire sealed through the glass. See Fig. 1.

Fleming found that when the carbon filament was rendered incandescent by

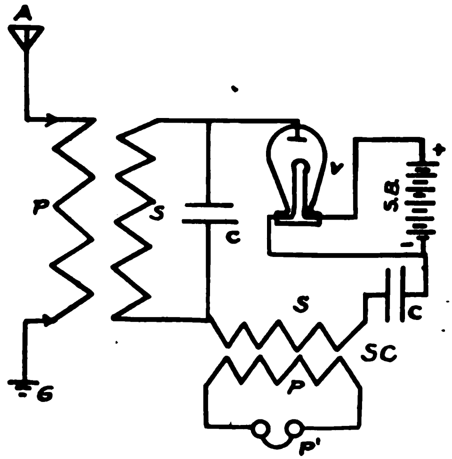
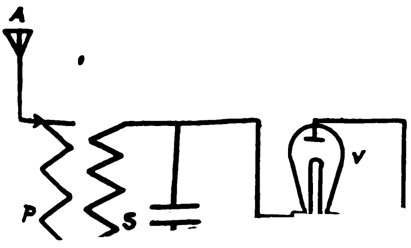


Fig. 2

an electric current the space between the filament and plate possessed unilateral conductivity, or, in other words, negative electricity will pass from the filament to the plate but not in the opposite direction. Prof. Pierce, of Harvard University, has shown this same state to exist in carborundum detectors. When a circuit is formed, as in Fig. 1, in which the metal plate, or grid, is connected to the negative wire of filament, oscillations set up in the aerial can be detected by the use of the head phones. On this basis the valve becomes a good detector for use in radiotelegraphy.

It has been stated by many prominent experimenters that the valve lacks the sensitiveness attributed to the crystal and liquid types. In the writer's experiments he has found that the valve is only slightly less sensitive than the bare-point electrolytic and perikon detectors, and far more efficient than the other liquid and crystal types. In general cases the experimenters who complain about the lack of sensitiveness of the valve are using improper and inefficient methods



a loose coupler to a circuit containing a Marconi valve and the secondary of an ordinary spark or induction coil. Coil should be at least of the 6-in. type, and preferably of the 10-in. pattern. The primary of the induction coil is in circuit with the telephones, the latter to be of usual wireless type. Condensers placed as shown. For good results the battery should be of the storage type with an e.m.f. of 12 volts. From experience the writer has found that dry batteries are not suitable for good work. This is probably due to the sudden fluctuations in voltage which is usual in dry batteries.

In action the oscillations from the transmitting station strike the aerial of the receiving station, are then transformed by the loose coupler, rectified by the valve and sent through the fine wire secondary of the spark coil. Naturally, the spark coil increases the current value, and the waves are readily detected in the head phones.

Experimenters who are complaining about the lack of sensitiveness of the Marconi valve detector will do well to try this arrangement, and I am sure there will be no future complaints about the delicacy of the valve for receiving long-distance stations.

WIRELESS TIME SERVICE

G. BIGOURDAN

The employment of wireless telegraphy has recently given an unexpected extension to the distribution of time-signals over long distances. The best-known European services are those of the radio-telegraphic stations of Paris (Eiffel Tower) and Norddeich, Germany. The Paris station, retarded several months by the Seine floods, began sending its signals at night only on May 23, 1910. From November 21, it also sent them in the morning. The times of signalling have since undergone some changes, especially through the change of the legal time brought about by the law of March 9, 1911.

The Norddeich station commenced its time-signals at about the same moment. But astronomers had already for several years carried out the wireless transmission of time-signals, and used them for the determination of longitude.

At first the precision aimed at did not surpass half a second; but nowadays there is a demand for all this precision arrived at in determining the time in the best-equipped observatories.

In Paris, the "warning signals" are at present given by hand, and the hour signals proper, three in number, are given will be, partly, at least, transformed into hour signals, given by the clock itself in an automatic and regular manner, for the employment of rhythmic signals would considerably increase the accuracy of reception.

We may imagine wheel trains, which, added to those of the clock, would effect the transformation of warning signals into hour signals, given, say, every second. But there are simpler means, and I propose to describe one device probably already put to other uses, which gives the best results for the purpose, although only carried out in a rough way.

The principle is as follows: An electric circuit is closed by the pendulum of a clock, the lower end of the pendulum touching the summit of a meniscus of mercury forming part of the circuit.

The very ordinary clock which I have experimented with has a pendulum with lenticular bob and rod of varnished wood. It beats seconds, and is suspended as usual by a flat steel spring. A copper wire, *b*, runs along the pendulum-rod, and its lower end *a* projects a few millimetres beyond the end of the pendulum. The wire *b* goes up to the metallic collar *c* of the same rod, and *c* is in contact with

the end of the tube. This tube is carried by a support capable of adjustment, especially as regards height.

It is seen at once that in order to make the clock give, say, one signal per second, it suffices to place the meniscus at the equilibrium position of the pendulum, and to adjust its height. For giving one signal every two seconds, the meniscus is brought to one of the extreme positions of the pendulum. Besides, each second can be subdivided, equally or unequally, by substituting several wires for the wire *a*, or by arranging several mercury drops in the track of the wire *a*. To suppress certain seconds, deflect the current from the circuit *a b c d e f g* by hand, or by an easily-devised mechanism.

The contact is highly adjustable. Its duration can be made to vary between 2-100ths and 3-10ths of a second, by choosing an appropriate radius for the drop. Longer durations could be obtained by employing a long meniscus.

A similar arrangement is very useful for working a chronograph, or relay, for driving a free pendulum, or regulating a series of clocks from a master clock. A feeble current suffices, and the break spark is barely perceptible, 2 to 4 volts being sufficient.

The friction produced by the passage of the wire *a* through the mercury every second only produces a slight effect on the clock used. With a meniscus traversed to the extent of 2 mm. it was not found necessary to increase the driving weight, and the amplitude only diminished to 1-10th of its value.

To show the passage of the current, I make it light a small lamp having a short metallic filament, such as are on the market, with a very short period of lighting and extinction. Thus one obtains almost instantaneous signals, which can be used for observing pendulum coincidences in determinations of gravitational force.

One could also obtain the marking of seconds, or fractions of seconds, in the photographic registration of transits.—"Comptes Rendus."

ARLINGTON NAVAL WIRELESS STATION WORKING

First tests of the navy's new high-power wireless station at Arlington, Va., made October 28th and 29th, were a complete success. Officers in charge decline to discuss the performance of the world's greatest wireless plant further than to say that the first step in a system which is to extend around the world, with stations at Colon, Hawaii, Guam, Pearl Harbor and the Philippines, and put every ship in the navy and the insular possessions in instant communication with the capital, has successfully been taken.

Wireless operators, professional and amateur, on one side of the globe have had their instruments at their ears straining to catch the faint buzzes as the powerful apparatus sputtered out its calls for sparked off N-A-R, the call for Key West, 975 miles off. No official messages were sent, but the results of the test were noted at all stations on the Atlantic coast, as well as at Key West and Colon.

The radius of the new plant will be about 3,000 miles when it is in working order. This range, probably the acme of wireless operations, will be attained gradually, and it may be weeks before the big plant is "tuned up" to its highest efficiency. Communication with the Pacific coast will be attempted only at night for the present, but throughout the day the Secretary of the Navy, at his desk in Washington, will be within instant communication with Key West, Guantanamo, Colon, the naval coaling

communicate with the powerful plant at Arlington, but they may relay messages to the various stations for transmission to Washington.

Three huge steel towers on the brow of a hill overlooking the Potomac and dwarfing the Washington Monument hold the aerials which fling off the messages to the ether. In their construction, skilled ironworkers who have braved death on a skyscraper declined to work at such dizzy heights. One tower is 600 ft. above the hill where its base rests, and that is 200 ft. above the river. The others measure 450 ft.

At the base of the towers are the sound-proof workrooms, quarters for the operators and barracks for the marines who will guard the towers. The base of the tallest of the structures is 150 ft. square, and the other two have 120-ft. bases.

The station, which has cost $200,000, is on the summit of a high hill about a mile south of the drill-field at Fort Meyer. The buildings consist of three brick buildings. One is occupied by the officer in charge of the station. Another is the "receiving" building. In it is the apparatus for the reception of messages. The building also contains an office for the officer in charge, an office for the operators, a dining-room, kitchen, living-room, for the personnel of the station, a room for experimental purposes, dormitories and a large reading-room. The third structure is known as the transmission building. It contains an engine-room, machine shop, laboratory and a radio museum. In the high-ceiled engine-room a 200 h.p. motor, belted to a 100 k.w. generator, is installed. A 15 k.w. oil-driven generator set is also used for charging storage batteries and conducting experimental work.

What is known as the inclined flat top antenna is used at the station. The ground connection is made by burying copper wire and common chicken netting over a considerable area. If, because of the dryness of the ground, a good con-

The two wings of the station are separated by short vestibules from the central machinery plant. The vestibules are wooden. The connections of the vestibules with the brick-work are padded with linofelt, which takes up the vibration from the machinery plant and avoids corresponding complications in the operating rooms. There are two of these rooms. One is occupied by the radio operators, the other by those who man the telephone and telegraph wires connecting the station with the outside world. The radio operators' room is unique. It is built somewhat upon the style of a huge refrigerator. It is absolutely sound-proof, and when its door is closed the radio operator on duty cannot be bothered by any sound from without, or by vibrations. The only entrance into the radio operating room is through a double refrigerator door. The room has no windows, is artificially lighted and ventilated. Even the air used in doing this is sound-proof, as it passes through a series of air ducts in which "baffle plates" are strung so as to baffle any noise that may attempt to creep with the ventilation into the radio operating room.

A separate room has been set apart for use by operators of the land wires. Connecting it with the sound-proof radio operating room is a telautograph. When a message is to be sent by wireless it is not taken through the refrigerator door into the radio operating room, but is laid down there by the outside operator through use of the telautograph. The outside operating room does not have to be storm- and vibration-proof and is connected with the outside world in three ways: by public telegraph, and private and public telephone. There is a private telephone wire leading direct from this outside operating room into the Bureau of Navigation in the Navy Department. This avoids any leak of official messages through use of the city telephone service. Should anything happen to this official wire the plant has

To man the station at Arlington twelve enlisted men are necessary, as it will be open for messages day and night, all but two of whom are to be expert electricians, radio operators and telegraphers specially trained for this service at the Naval Electrician School at the Brooklyn Navy Yard. The duty is very exacting and requires the services of men of a high order of intelligence.

To avoid smoke, dust and vibration the power for the operation of the plant is derived from the electric conduits of the city of Washington. This power drives a 200 h.p. electric motor, which in turn drives what is described as a 100 k.w. 500-cycle alternating generating plant. Two currents, one of which is primary and of 100 volts, the other secondary and of 12,500 volts, are produced by this generator. The primary current passes into a novel transformer, which "steps up," and is increased into a high current of 12,500 volts in the secondary circuit.

LOW POTENTIAL ELECTRIC GAS-LIGHTING

M. C. SAEGER

It should not be considered a luxury to possess an electric gas-lighting equipment, and the accompanying illustrations will show how easy it is to construct a coil suitable for gas-lighting purposes.

A.

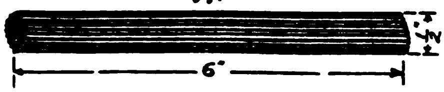
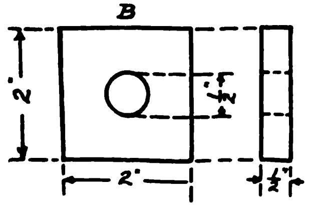


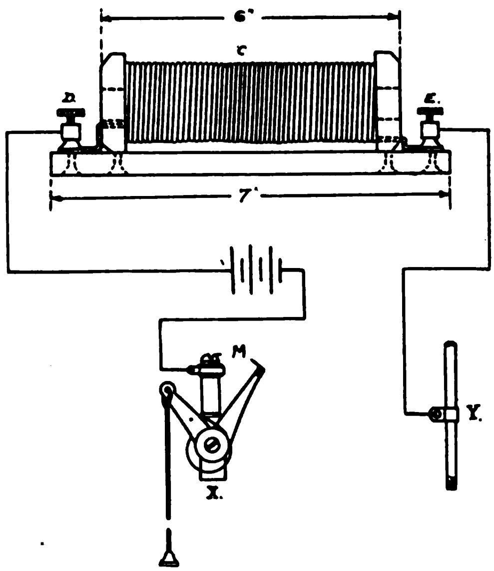
Fig. *A* shows a cylindrical core 6 in. long and ½ in. in diameter, composed of No. 14 soft iron wire. A small piece of wire or cord should be tied around each end of the core to hold the wires in place and the core must then be immersed in shellac and left to dry.

A piece of "empire cloth" or paraffined paper, 5 x 2½ in. in size, should be wrapped around the core and two blocks of wood, as in Fig. *B*, slipped over the ends of the core. Three layers of No. 15

B



B.&S. gauge, cotton-covered wire are wound on the core, care being taken that the wire is wound on evenly, as in Fig. *C*. One end of the wire is to be connected to terminal *D* and the other to terminal *E*.



when three dry cells of the high amperage or ignition type are connected in series with it.

Fig. *X* shows a design of a plain make-and-break igniter which has but few parts to get out of order. Fig. *Y* is a portion of a gas main which is used to ground the wire leading from terminal *E*. One coil of the type just described will operate as many gas burners as may be desired.

According to the *Financial News*, a ton of steel made into hairsprings for

WIRELESS OPERATORS RUSH TO GET LICENSES

Veterans and Amateurs Must Comply with Federal Law by December 13

Since the first of the month the office of the electrical school at the Brooklyn Navy Yard has daily been crowded with veteran, neophytic and embryonic wireless operators, all panting to write down what they know about radio communication, its uses and abuses, and so get a license from the Department of Commerce and Labor.

All this rush is due to the fact that on December 13 there goes into effect an act for the regulation of radio communication, whereby all wireless operators and all apparatus which work across State lines or can communicate with ships at sea are required to be licensed.

This act is one of the by-products of the Berlin international treaty, ratified in April by the Senate.

Examinations are being held at United States navy yards and army posts all over the country during this month, and according to reports thousands of operators are availing themselves of the opportunity of getting themselves registered as regular flashers before December 13.

The fact that there are some 10,000 wireless stations, most of them amateur ones, around New York accounts in the minds of the examiners at the Brooklyn navy yard for the daily crush in their office. The amateurs know that the act doesn't pass them by entirely.

The veriest beginner amusing himself on a housetop in Flatbush by sending burning messages to his up-to-date friend in South Brooklyn is aware of the fact that he must get a second grade license right away if he wants to practise radio communication, or run the risk of having his precious paraphernalia pulled down by a stealthy inspector.

Anybody who wants a license must first go to the Custom House or to the electrical school at the navy yard and present an application, telling whether

written ones, and they are corrected by the examiners under the supervision of the Department of Commerce and Labor.

One of the questions which is likely to hit a trembling beginner in the face is: "How can you tell if your antenna is radiating?"

The applicants for commercial licenses, of which there are now five grades, may be asked to "describe in detail the adjustment of a transmitter for a certain wave-length (as 600 meters) so that only a single hump would be present."

Applicants for third grade licenses, which is the technical class for experiment and instruction, also have a little leeway in the matter of questions.

Everybody, regardless of class or grade, swears to keep secret any messages he may pluck out of the air, unless ordered to divulge those messages by a court of competent jurisdiction.

This stipulation was embodied in one of the most important amendments made by the House when the administration bill for Federal control of wireless operations passed through its hands. Furthermore, the beardless dabbler in sparks solemnly vows to cease troubling the air with his machinations when there are important messages flaring around the sky.

Apparently the amateurs about New York are right up to the scratch when it comes to swearing or knowing their business, for 90 per cent. of all the applicants examined at the navy yard during the first three weeks passed, according to one of the examining officers.

One fact the officers have noticed with surprise during the kaleidoscopic comings and goings of applicants; that is, that there have been no women in the line.

One recalled yesterday, however, that when the wireless division of the Com-

SOME OF THE CURIOUS SUPERSTITIONS OF SAILORS

Why does a seafaring man—captain, cook or cabin boy—consider it unlucky to ship a man who neglected to pay his laundry bill?

Why does a sailor nearing port after a lengthy voyage gather up old clothes and shoes unfit for further use and ceremoniously commit them to the deep?

Why does he like to sail on a ship which displays a shark's tail firmly nailed to the bowsprit or jib-boom?

Why does he like cats?

Why does he place great faith in the merits of a pig as a weather prophet?

The simplest answer to these questions is—because the average sailor is superstitious.

During rough weather at sea it would be hard to convince any old-time sailor that there wasn't a Jonah aboard. Many captains of the old school, who ought to know better, are so superstitious in this respect that it is not uncommon for them to take intense dislike to officers who have happened apparently to be the harbingers of bad weather, and especially fog. It is quite usual on board ship to find members of the crew nicknamed "Foggy Jones," "Heavy Weather Bill," or "Squally Jack."

Cats on board ship are considered lucky, and many a stray one finds a comfortable home and careful attention with Jack for its friend, although, on the other hand, our domestic pet has at times been held responsible for the continuance of bad weather and had to play the part of Jonah to the full extent.

Perhaps the most amusing superstition of the sailor is considering it a crime for any member of the crew to leave port with his washing bill unpaid, as this neglect is generally believed to be the cause of bad weather being encountered just after leaving port.

The ways of invoking the gods of the elements to bestow fair weather and winds are numerous. Among the best known is that when nearing port after a lengthy voyage. Old clothes and shoes unfit for further wear are collected and thrown overboard with much ceremony and faith

One of the most curious superstitions is that dealing with the capture of a shark. The natural dread and antipathy with which those monsters of the deep are viewed cause a capture to be hailed with much rejoicing.

Thirty Years of Edison Light

INVENTOR FIRST TURNED ON CURRENT IN NEW YORK, SEPTEMBER 3, 1882

Thomas A. Edison had another anniversary and an important one for himself and New York City. On September 3d, 1882, Mr. Edison started in operation the world's first central station for the supply of incandescent electric lighting for commercial purposes. This was in an old brick building, a converted warehouse, in lower Pearl Street. The steam was turned into a single dynamo and current sent through underground cables into about 400 lamps that had been distributed through a territory about a mile square.

The newspaper accounts of the demonstration read curiously in this day. While it was generally admitted that the exhibition had been a success so far as proving that the incandescent bulbs give light, there was a dubious feeling running through the reports as to whether the invention could be made commercially successful.

Since that day New York has had electric lighting with only two interruptions, the second and most serious one of which was in 1890, when the Pearl Street station was destroyed by fire. Thirty years ago 15 miles of underground cable sufficed to connect all the installations. Now 1,400 miles of "underground" sends current to the 5,250,000 lamps, while the bills are ticked off by 159,000 meters.

The first electric motor was put on the lines in 1884. Today in New York City 337,000 h.p. is used in motors. Instead of the old reconstructed brick building at No. 257 Pearl Street that housed the

CHANGE IN WIRELESS CALLS

When the United States Senate subscribed to the Berlin Conference, April 3d, it made it necessary to change the calls, both of the commercial and amateur stations within the United States. For this purpose the calls beginning with KOA to KZZ, inclusive, and those beginning with N and W, have been assigned to the United States. These are all three-letter calls and will be assigned to the Government and commercial stations. So far as possible the Government stations will begin with N and the commercial and ship stations of the Atlantic Coast with K, and those on the Pacific Coast with W. This is an insufficient number of calls for the whole United States and application has been made to the Convention for 156 additional calls. These calls will be assigned when the licenses of the stations are issued. Because it will be impossible to issue these licenses entirely before the first of January, it will be impossible to get out a regular issue of the Government Call List on the first of the coming year. This list will appear early in the Spring and will contain all revised calls.

For the amateur calls, the system of numbers has been adopted. Each call will contain at least three items, the first of which is a number representing the district in which the amateur is located. These calls will be assigned by the radio inspector and will be assigned in order of application of licenses. If the number is followed by two letters, this will permit of less than 600 calls, which is far insufficient for any district. When this assignment is used up, the number will be followed by three letters. A station in New England will have its call letter beginning with the Fig. 1, because it is in the first district. The calls X, Y and Z will be omitted from general amateur use. These calls are to be reserved for special licenses. A call beginning with a figure followed by the letter X and some other distinctive letter, will represent an experimental station. That containing a Y in place of the X is for a technical or training school. That containing a Z is for a special amateur station. In case this number of calls is not sufficient for technical, experimental and special amateur stations, it will be necessary to resort to three letters preceded by a figure. The radio inspector will assign these calls and his orders are to keep a chart in his office in which these calls may be found.

Any amateur who is found using any call other than that which is assigned by the radio inspector will be punished in the same way that a person forging another's name will be punished. In any district it will always be necessary to use the figure preceding the call to distinguish it from commercial stations and amateur stations of other districts. In the assignment of calls such combinations of letters as SOS, PRB, and calls such as III, SSS, will be omitted for obvious reasons. These calls will be ready for use about the 13th of December, when the new law goes into effect.

Study Wireless in Grammar School

The Freeman school of North Adams, Mass., probably is the first grammar school in the state where pupils are given an opportunity to study wireless telegraphy.

Principal Winthrop H. Lamb of the Freeman school has installed a wireless telegraph station at the school and will teach all the boys who wish to take the course the rudiments of wireless telegraphy. Mr. Lamb has had considerable experience with wireless telegraphy, and will supervise the work of the boys in this class. It is not expected that the course will equip the boys to be expert operators, but it is designed to give them an insight into a science which is deeply interesting and may prove profitable to the boys in after life.

The receiving and transmitting instruments are located in Principal Lamb's office, and the wires are on the roof of the building. The work of fitting up the station was completed under the direction of Warren Ford.

Many of the boys at the school have expressed an eagerness to take up the course which will undoubtedly prove both interesting and profitable.

School Days

"Oh, Ella, your exercise is simply full of mistakes."

"I did it on purpose so that my master will stay longer with me."—*Fliegende Blaetter*.

EDITORIAL

With the first number of a new volume and a new year, we again extend to our readers our thanks for their support, and our best wishes that the forthcoming year may be a fruitful one for each and all. We venture, also, to voice the aspiration that ELECTRICIAN AND MECHANIC may be able to help a little toward the achievement of this end. Our mission is to aid our readers, and this is our highest ambition, for, in this world, he who is most helpful to his fellow-men reaps the richest harvest of actual success, and need not, as a rule, worry about the material rewards of his efforts.

In order that the magazine may be as helpful to its readers as they would wish, we must again emphasize the fact that co-operation is necessary. The editors are not infallible. Their best efforts are directed toward making a magazine which will be of the utmost possible use, but every expression of opinion on the part of any reader as to what will help him solve his problems and fill his wants will help the editors to make a better magazine for all. We are always glad to receive letters telling of your troubles, your needs, and your desires, either to help us in the problem of producing the magazine or in order that we may aid you directly and immediately by answering your questions.

At this season of the year it is the custom of the American people to subscribe for the magazines which they desire for the next year. Undoubtedly three-fourths of all the magazine subscriptions of the United States are entered during the months of December and January. We would not only like to have our readers renew their own subscriptions at this period, but it would help us a great deal if they would interest their friends, by showing them the magazine at this particular season of the year, and inducing them to send in subscriptions. We have, for several months past, published in the advertising pages an offer whereby some very valuable technical books can be obtained in connection with the subscriptions, at a very small addition to the regular price, and if these offers are called to the attention of non-subscribers, they will undoubtedly feel interested. Another offer which is interesting to those not already subscribers to the magazine is that, as long as the supply lasts, we will give any new subscriber who asks for it a dozen back numbers containing a large number of valuable and practical hints and articles on all phases of mechanical effort.

To any of our readers who are willing to start, even to a small degree, in the interesting business of getting subscriptions, we are prepared to furnish outfits, consisting of sample copies and receipt forms, and to give them a good commission on any subscriptions they may get. We shall be glad to hear from those interested in this proposition.

As this number goes to press, the time is approaching when the new wireless law, for the regulation of amateurs, goes into effect, and examinations for licenses are being given in many localities throughout the country. There has been much delay in the preliminary arrangements for the enforcement of the law, and ELECTRICIAN AND MECHANIC undoubtedly performed a great service to wireless interests throughout the country, by making accessible in its last three numbers the terms of the laws and regulations, which were not ready for general distribution at the times when we printed them. There was also considerable delay in the appointment of

wireless inspectors in many districts, and it is not probable that all of the licenses applied for will be issued before the 13th of December. The amount of work devolving upon the inspectors was tremendous. It is stated that in the New York district alone more than ten thousand applications were filed within three weeks after the appointment of the inspectors.

It is needless to say that the Government will not enforce the letter of the law to the disadvantage of any individual who has made a sincere effort to comply with it, and that no prosecutions will be undertaken for infringements caused by its own delay. Nevertheless, any amateur possessing a station who has not made known his existence to the inspector in his district and made the necessary application for license on the proper form may find himself in serious trouble as soon as the inspectors can get to his case, and we would advise every reader to be sure, by personal application to the nearest wireless inspector, that he is in full conformity with the law.

It is doubtless true that many hundreds feel that the law unduly hampers their activities, and that all of its provisions are not for the best interests of the art. Nevertheless, the law has been enacted and it must be obeyed. Its weaknesses will be discovered after it has gone into effect; and when a sufficient time has elapsed for a concensus of opinion to be arrived at, an organized effort to amend it in the interests of more latitude for amateurs, and especially freedom to use a longer wave-length, may prove successful. Before such an attempt can be made, however, a body of facts must be accumulated and logical reasons, supported by evidence, produced to show the hardships which it is alleged will exist.

A striking result of the new wireless laws, in their application to steamships, is that there is a great scarcity of operators. It is almost impossible to get enough expert men to fill the responsible positions, and there is no doubt that many half-trained operators are now some time to come, there will be plenty of berths for good operators. In spite of this, the various commercial schools report that it is very difficult to get young men to enroll, and under the circumstances we would advise our readers who are interested in wireless telegraphy to study carefully the possibilities of this profession, and write to the various wireless schools advertising in this issue for information. We would not say that the life of a wireless operator is a bed of roses—like every other desirable position in the world it demands stamina—but a young man with a serious purpose, who is willing to put his mind upon his work and embark upon it with enthusiasm, can find in wireless telegraphy an opportunity for getting a fair salary, a responsible position, and a chance to see something of the world.

An index to Volume XXV of ELECTRICIAN AND MECHANIC has been prepared and will be mailed to any of our readers who may apply for it and enclose a stamp for return postage. If you desire to have the book bound, the index and title page are essential to the appearance of the volume.

This issue of ELECTRICIAN AND MECHANIC goes to press before the close of either of the competitions which were announced in the October and December issues. A prize competition article is published on page 13 of this issue and others which are considered worthy of publication will be presented in succeeding issues of the magazine. This competition offers the unknown writer an opportunity which he should not overlook. The prize will go to the person sending in the best article which fully describes the construction of some piece of experimental apparatus. No limit is placed on the length of the article and the chief requirement is that it be thoroughly practical. As the contest does not close until March 1, 1913, there is still ample time to enter the competition.

The contest for the best phrase which

BEST RADIO OPERATORS PRODUCTS OF AMATEUR FIELD

"Amateur wireless operators, generally considered to be detrimental to the use of the wireless, are useful to the wireless business," said H. C. Gawler, recently appointed supervisor of New England wireless stations. Mr. Gawler said that the amateurs did not cause interruptions of communications nearly as much as they are credited with doing, and that were it not for the amateurs, many of the best operators in the commercial fields would not have taken up wireless at all. From the extensive field of amateurs, the greater part of professional operators are selected.

In connection with interruptions Mr. Gawler said that many of the commercial ships themselves cause the disturbance that breaks the connection by the character of tuning waves from their own instruments. He also said that some of the amateur stations are more efficient and better equipped with more up-to-date instruments than are many of the commercial stations.

Mr. Gawler is given the entire New England district to look after. It is his duty to issue licenses to amateur operators who comply with the regulations regarding stations, operators and instruments.

Up to the present time about 200 amateurs have applied to Mr. Gawler for licenses, all from Boston or the immediate vicinity.

Mr. Gawler is classing all amateur stations as "coast" stations until he finds those that do not interfere with commercial stations. When he finds the range of a station too short to bother the commercial or official coast stations, he classes them as inland stations.

In his work here Mr. Gawler stated that his duty was greatly facilitated by customs officers who had gathered data covering much ground and who assisted him considerably. He also praised the other branches of the government service.

New Wireless Telephone

Dr. Riccardo Moretti of Rome claims to have solved the problem of wireless telephony by means of a special generator of electric oscillations of his invention, which has been successfully experimented through one of which flows a thin continuous jet of water.

The water is evaporated by an electric spark between the ends of the poles, and an alternating current of extraordinary rapidity is consequently generated, since the oscillations thus produced are calculated at several hundred thousands per second. As the oscillations exceed in number and rapidity the vocal vibrations, by means of this generator it is possible to transmit the voice over long distances.

Dr. Moretti has experimented with his invention in connection with the naval wireless installations with the addition of ordinary telephone receivers and transmitters, but he is now working on a hydraulic transmitter, particulars of which are still undivulged as it has not yet been patented abroad. Dr. Moretti is the nephew of Prof. Marchiafava, the Pope's physician.

He admits that he owes his invention to Marconi, and insists that it is nothing else but an application of wireless telegraphy to the telephone. Dr. Moretti has granted the prior rights of his invention to the Government and, in fact, a wireless telephone station is already being installed between Tripoli and Rome. Meanwhile an Italian syndicate has been formed for the exploitation of the Moretti generator of electric oscillations.

Wireless Time Signals Between Europe and America

The exact time at a given moment in America and Europe will be established shortly by wireless telegraphy. About the middle of November it was possible for the first time to establish with precision the longitudes of America and Europe in their relation to each other by the exchange of wireless signals between the great naval wireless station at Arlington, Va., the Eiffel tower in Paris and other European stations.

H. H. Hough, at the international time conference at Paris, declared that the observatory in Washington was now distributing time with errors of only one-thousandth part of a second. Hitherto European and American time has been established by cable, allowances being

CARE OF GAS-ENGINE BATTERIES

Gas-engine users who want the best battery ignition, do not use only five batteries in series as is commonly done, but use what is known as the "series multiple" arrangement, in which four groups, five in a group, are used. When 20 cells are so arranged, their life is *8 times* that of 5 cells. But even with this arrangement, the battery will give trouble *sometimes*, as regardless of *the number* or kind of batteries used, or their arrangement, batteries become exhausted with age, even if not in use.

It will be well to remember that a battery will not give a uniform spark all day. In the morning, when the engine is first started, the spark may be entirely satisfactory. In the afternoon, after the engine has run several hours, and the batteries begin to weaken, the spark weakens, and the engine begins to miss. This means that the batteries are getting weaker. Do not attempt to remedy this trouble by adjusting the engine igniter, but give the batteries the attention they demand.

Rough treatment tends to shorten the life of batteries. Handle them gently. Do not remove the pasteboard covers.

Excessive heat shortens the life of batteries; cold makes them inoperative until thawed out.

Don't keep batteries in a hot place. Don't lay them on sides, but always stand on end. Don't buy so many that you will have to keep them on hand for months. Get *new fresh* cells as needed.

Slow-speed engine-timed built-in magnetos are an up-to-date device for the gas engine. They are independent of heat and cold. As the magneto forms part of the engine, it will run anywhere and give a good spark as long as the engine runs. The "built-in" type of magneto should always be specified on engines to be used for portable and farm work, as they are entirely independent of the many conditions which so seriously affect battery ignition. Magneto ignition is always uniform, as it depends upon the engine power and not chemicals, for its generation. The best magnetos have means for visibly timing them, so that anyone can readily determine if the engine is properly in time, and if it is not, one can adjust the magneto.

THE CHEAP BLACKENING OF BRASS

The following solution for blackening brass is nothing new; in fact, it has been known for a long time. Owing to its cheapness, ease in working, and adaptability for many purposes, it has been deemed advisable to bring it again to notice. Many platers, of course, will recognize it as an old solution known to the plating industry for many years; but they may not have realized its advantages for some classes of work. The solution is made as follows:

Water	1 gal.
Sugar of lead	8 oz.
Hyposulphite of soda	8 oz.

The solution is used as hot as possible, and the brass work is simply dipped in it, and allowed to remain until black. This takes about a minute or less. The articles are then rinsed in cold water, then in hot water, and dried. If scratch-brushed dry, the black deposit will have a high luster.

When dipped into the solution, the surface of the brass article becomes yellow, then blue, and finally black. The article should not be taken out until all the surface has become blackened. The deposit on it is sulphide of lead. The articles should always be lacquered, as otherwise the black deposit is likely to oxidize and fade; but if coated with lacquer, it seems to be quite permanent.

For a cheap class of goods that require a black finish, this solution can frequently be used to a good advantage. It requires no electric current, being used as a dip. The color, to be sure, is not coal black, but resembles a graphite black more than anything else, and has a slight gray shade. It is sufficiently black, however, to answer many purposes, and it is so easily applied that it can be used on cheap goods with only a slight increase in cost.—*Brass World.*

CORRESPONDENCE.

Editors, ELECTRICIAN AND MECHANIC,

Dear Sirs: I would like to say a few words about the gyroscopic action in a windmill.

If it were not for the fact that there is necessarily a little play to the swivel joint at the top of the tower and that this allows the windmill to turn so as to face the wind, the gyroscopic resistance to turning the windmill out of the wind would be absent.

The action of the windmill in this respect is complicated by the fact that when the windmill is turned part way on, some of the vanes of the windwheel are nearly perpendicular to the wind, while others are nearly edgewise to it. In such a position as shown in Fig. 1, with the lower vanes catching most of the wind, the bottom of the wheel will be pushed back. Now a force applied, as if at *A*, to push the edge *A* back, will, by gyroscopic action, be carried around and act as if it were applied at *B*. Thus the action of the force applied to turn the windmill off will push the top of the wheel back and the bottom forward. As the bottom was previously pushed back by the pressure of the wind, it will have a little play-room, and gyroscopic forces will come into action.

Of course, the tail can be brought up, parallel to the wheel, but this will be done against the pressure of the wind. The relation of these facts to the windmill, storage battery, charging problem may not be entirely obvious, so permit me to add a word.

The reaction of the vertical shaft of a power windmill tends to turn the windmill either into or out of the wind, according to the design of the windmill. It would seem desirable to use this property to turn the windmill off and avoid overloading the dynamo, but it is a question whether gyroscopic action would not make this impracticable.

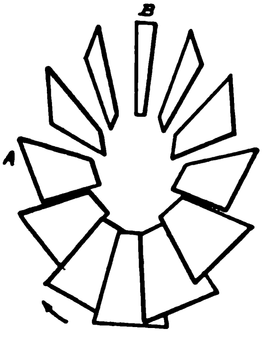


Fig. 1

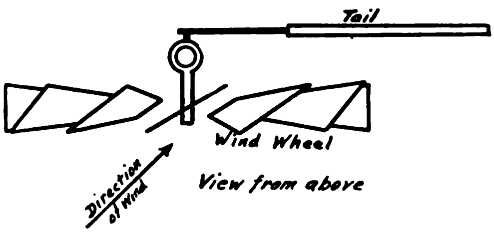


Fig. 2

My own windmill tends to turn into the wind as the load increases, so I have added a side rudder. I would like to hear from anyone who has had experience with a windmill that turns itself off when the load increases.

E. A. FINCH.

Editors, ELECTRICIAN AND MECHANIC,

The Wireless Club of Baltimore was reorganized on November 18, 1912, and formed into the Radio Club of Baltimore, with the following officers: president, Winters Jones; vice-president, Raymond Kendall; secretary, Alvin L. Miller; treasurer, Louis E. Richwien. Anyone wishing particulars as to membership, etc., in the above-mentioned association should communicate direct with either the president (whose address is 728 N. Monroe St., Baltimore, Md.) or the secretary.

Very truly yours,
THE RADIO CLUB OF BALTIMORE,
Per A. L. Miller, *Secretary*.

Editors, ELECTRICIAN AND MECHANIC,

Will you be so kind as to print the following notice in your excellent magazine?

The Electro-Mechanical Association of Columbus, Ohio, with the following officers: Howard Meyer, president; Robert Poole, vice-president; Stephen Davis, treasurer; Fred Dennis, chairman; Chester Otto, librarian; John Dolby, secretary, 512 W. State St., extends to all prospective members a most hearty welcome. The name of the Association was derived from the magazine of Knowledge, "ELECTRICIAN AND MECHANIC." Atpresent the Association has no complete wireless station, but expects to have a good equipment of electrical and mechanical apparatus in a short time. A library has already been established with each month's ELECTRICIAN AND MECHANIC at hand at all times.

QUESTIONS AND ANSWERS

Questions on electrical and mechanical subjects of general interest will be answered, as far as possible, in this department, free of charge. The writer must give his name and address, and the answer will be published under his initials and town; but, if he so requests, anything which may identify him will be withheld. **Questions must be written only on one side of the sheet, on a sheet of paper separate from all other contents of the letter, and only three questions may be sent at one time.** No attention will be given to questions which do not follow these rules.

Owing to the large number of questions received, it is rarely that a reply can be given in the first issue after receipt. Questions for which a speedy reply is desired will be answered by mail if fifty cents is enclosed. This amount is not to be considered as payment for reply, but is simply to cover clerical expenses, postage and cost of letter writing. As the time required to get a question satisfactorily answered varies, we cannot guarantee to answer within a definite time.

If a question entails an inordinate amount of research or calculation, a special charge of one dollar or more will be made, depending on the amount of labor required. Readers will, in every case, be notified if such a charge must be made, and the work will not be done unless desired and paid for.

1899. **Blitzen Transformer.** P. R. L., Lebanon, Pa., asks: I have a lot of wire as per sample enclosed, which you will note is single-covered, size No. 31 American Wire Gauge. What I would like to know is, can I use this wire for the construction of the secondaries for the ¼ and ½ transformer (Blitzen), as described in the August issue of the *Electrician and Mechanic?* I would think the primary wire for the ¼ and ½ k.w. Blitzen transformer would be changed to different sizes to be used in connection with the above size wire. If so, kindly advise what sizes I should use for the primaries, both for the ½ and ¼ k.w. transformer. Ans.—The wire is suitable for use in the ½ k.w. transformer, providing you use the number of turns specified in the article. The primary winding need not be changed.

1900. **Right Over Left Transposition.** C. O. K., Port Moody, B.C., says: I have found some trouble in knowing what is a right over left transposition telephone or high tension, for the reason that what is known as right over left in the Eastern States is left over right on this coast. Is there a standard ruling on this point, and if so, please let me know it, as I would like to know who is doing the work properly? Ans.—A "right over left" transposition is the same wherever transpositions are made. The peculiarity you notice is due to a difference in the pin count. Some companies count their pins with the back to the controlling office, while others count them facing it. In the first instance, looking in the direction of the pin count, if the left-hand wire dips under the right-hand wire, the transposition is a "right over left." Facing the other way and counting the pins in the opposite direction would make the same transposition a "left over right." There is no standard ruling on this point, but as a general thing, a line starting at the *A* pole with a right over left transposition, would continue that construction throughout.

1901. **Field Magnet.** H. R., Holden, Mass., has a small toothed armature, dimensions being 3 in. in diameter, 2½ in. in length. Winding consists of 44 wires per slot, in 20 slots. Commutator has 20 segments. He asks some advice as to the proper sort of field magnet to make. Ans.—Of the three designs you have sketched we would advise the upright bipolar, somewhat resembling the typical Edison. Do not, how- symmetrical four-pole field would be to have the diameter twice the length. Probably you intend to use cast iron for the magnet, and if this is the case, do not have the section within the spools less than 4 sq. in. Round spools are the easiest to wind, and in this case have the iron about 2¼ in. in diameter. The section of iron in the upper block should be fully as great, say 1½ x 2¾ in. Let field bore be 3¹⁄₁₆ in. Each of the two spools should be wound with 2½ lbs. of No. 25 single cotton-covered wire. At a speed of 2,400 revolutions, armature should generate about 50 volts; allowable current will be 4 amperes.

1902. **Transformer Winding.** H. W., Ohio, asks: I have a 1¼ in. iron core for closed core transformer 8 x 8 in. I also have a secondary from a large induction coil containing 5 lbs. of No. 30 enameled wire. (1) How much and what size wire ought I use for the primary on the above core, so I could use same on 110 volts, 60-cycle alternating? (2) How many glass plates coated on both sides 10 x 12 would be needed for the condenser? Ans.—(1) A transformer such as this would be, when constructed, very inefficient and unsatisfactory. If you want to try it use 6 lbs. of No. 14 wire on the primary. (2) About 30; but the new law for amateur stations will not permit over one-third of this amount being used.

1903. **Receiving Transformer.** W. H. W., Asbury Park, N.J., asks: Can you give me specifications for building an inductive tuner that will be capable of tuning to a wave such as is used by the Glace Bay, Clifden and New Arlington stations? This tuner to be used with an aerial 75 ft. in length, six strands. Ans.—Primary, 7 x 5 in. wound with No. 26 wire. Secondary, 7 x 4¼ in. wound with No. 30 wire. Two series loading coils for the primary, each of the same dimensions as the primary. One coil should have taps every 100 turns.

1904. **Slide Wire Bridge.** R. F. A., Carmine, Tex., asks: (1) I wish to make a resistance set for a slide wire bridge with steps as follows, viz.: 5, 10, 25, 50, 100, 300, 500, 1,000 and 5,000 ohms, and wish to know what size German silver wire to use. (2) What is the largest number of telephones that can be used on one line (bridging); phones are equipped with 5 bar generators and 2,500 ohm ringers? Ans.—(1) The resistance of German silver wire varies greatly with the

(2) Line conditions, such as length, size of wire, quality of construction, etc., determine to a great extent the number of instruments that can be placed on one circuit. The fact should always be kept in mind that as all the bridging ringers operate at once, great confusion will result if more than a reasonable number of instruments are used. The actual number of instruments it is possible to operate on one line is limited only by the power of the generators and the sensitiveness of the ringers. 1,600 ohms is becoming a standard resistance for bridging ringer movements, as 2,000 and 2,500 ohm ringers do not give a very loud ring, the stroke being rather weak, owing to the small amount of current that can force its way through the high-resistance coils. The 1,600 ohm ringer gives a sufficiently powerful ring to insure satisfactory operation, and permits the maximum number of instruments to be placed on one line. Four bar generators are the standard for bridging service, and the greatest number of instruments it is practicable to operate on one line may be successfully rung with them. Where line conditions are very severe, or where a large number of instruments are used, five bar generators are desirable. Four bar 1,600 ohm ringer instruments will operate satisfactorily 20 per line; 5 bar 1,600 ohm 25 per line, or more if conditions are favorable.

1905. **Induction Motor.** A. H. J., Montreal, Can., has a 300 h.p. and a 10 h.p. induction motor that are disused during the winter, and are compelled to remain in places that are very damp. He asks how he can keep them dry. Will the ordinary electric lighting current be helpful? Ans.—It would seem practicable to box the motors where they are, using matched boards, and covering the whole with tarred paper. Have a double pane of glass in each box, an air space being between, and a thermometer just within. Have several incandescent lamps near the floor in the large case, but perhaps a single one will suffice for the small one. The window will be useful for keeping track of the temperature within, also for reaching through and renewing a lamp, if one burns out. The boxes can be made in a permanent manner, put together on certain sides with screws, whereby for times of use of the motors the sides can be removed and then assembled again for the next winter's storage. The line wires for bringing the lighting current may be somewhat undersized, whereby the lamps will not get full voltage, and by burning somewhat dimly will last all winter. Your second question, as to the method of finding how many poles an induction motor has, can be answered in several ways. Often the information is given directly on the name plate. Thus there may be given the name of the type or class as 1–8–10–900. These numbers would mean "Induction–8 poles–10 h.p.–900 revolutions per minute. If the number of poles was not thus given, but the cycles and speed, you can compute the number by applying the definition that the cycles per second equal the number of pairs of poles ... marked 60 cycles and 150 revolutions per minute, the number of poles will be 48.

1906. **Drum Armature.** A. J. A., Lithonia, Ga., has a drum armature 4 in. in diameter and 3½ in. in length, space for wires being 18 holes ½ in. in diameter. He wishes to make a field magnet that will permit machine to be used as a generator to be driven by a windmill at 450 revolutions per minute, and develop 35 volts and 10 amperes for charging 14 cells of storage battery. He sends a sketch of a four-pole field magnet, representing a wrought iron ring about 15 in. in outside diameter, of ¾ x 4 in. section, with radial cast-iron poles. He asks if the design is good, and what a proper winding should be. Ans.—At the speed you propose, the greatest voltage for a 10-ampere current is about 20. Therefore you would have to double some factor, presumably the speed. Again, a four-pole field magnet does not very well fit the armature you have. To be in economical proportions, the diameter of armature should be about twice the axial length. Yours is very good, however, for a two-pole field. Again, for four poles the number of armature slots should be divisible by four, or in case you preferred to utilize a series armature winding, it should differ from unity by such a divisible number. If you did put a four-pole winding on present core, a given coil should go from slot 1 to slot 5, and then when on opposite side of core, from slot 10 to slot 14. You will find it much simpler, and giving far better commutation, to adopt a simple two-pole field magnet. Armature can then be wound with No. 17 wire, 48 or more wires per slot. You have shown pole cores about twice as long as are necessary. Let space between tips of pole pieces be ¾ in. at center of armature, and about 1¼ in. at edges of core. You will find helpful descriptions of a two-pole design in Watson's "How to Make a One-Kilowatt Dynamo."

1907. **Mechanical Drawing.** F. M., Harrisburg, Ore., writes: I have been unable to make satisfactory drawings in ink, as the ink does not feed down the pen with sufficient regularity to make clear, even lines. When the pen is adjusted for fine lines, the ink will not feed at all. The drawing instruments are almost new, the ink a standard article and the paper a good quality of drawing paper. Can you suggest any remedy for my difficulty? Ans.—Although your instruments are new, the ruling pens may not be ground exactly right, and it will be well to look them over carefully and see if they are quite sharp, smooth and well rounded at the points. If the nibs of the pen are not of exactly the same length, this might cause the trouble. The ink you mention is a standard ink, but you may have left the bottle uncorked for too long a period and the ink may have thickened. Try a fresh bottle of Post's or Higgins' India ink and see if you get any better results. Clean your pen often and have a small cloth handy, so that you can wipe the nibs carefully before you fill the pen and before you put it away. If ink is allowed to harden on the points of the pens it

1908. **Enameled Wire Medical Coil.** H. S. S. San Francisco, Cal., asks: If there is any medical coil with enamel wire on the primary, and whether it is practical to put enamel wire on both primary and secondary. Ans.—It has been argued by several manufacturers that enameled wire is superior to cotton- or silk-covered wire in the construction of coils. It is more customary to use it on secondary windings than on primary windings, because of the fact that the primary is more liable to be subjected to undue heating than is the secondary. Still, satisfactory coils have been constructed with enamel wire on both the primary and secondary.

1909. **Rectifiers.** W. S. H., Carleton Place, Ont., asks: (1) Would you please tell me how the late models of rectifiers are made? Is it with wire? They do not appear to have jars such as the electrolytic type, *viz.*, lead and aluminum plates. Do you print anything on the subject? (2) Where is the cheapest place to buy a small ohmmeter? (3) Is the "Atlas" storage battery a good make? I believe they sell a 6-60 A.-H. battery at $5.00. Where are they located? Ans.—(1) There are several types of rectifiers constructed without the use of an electrolyte. The one which you probably have reference to is the magnetic rectifier. This type of rectifier is based on the principle that the poles of an electromagnet depend on the direction of the current. When the current is flowing in the positive direction an armature on the end of the magnet permits current to flow in the external circuit, but when the direction is reversed the pole of the magnet changes, causing the armature to break the external circuit, so that the result is a direct pulsation current in the external circuit. As yet nothing has been printed in this magazine on the subject, as the matter is generally understood by persons using such rectifiers. (2) Are you sure that you want an ohmmeter? These instruments are not in very general use. Any reliable electrical dealer should be able to furnish you with such an instrument. A fair price for a good instrument is about $40.00. (3) We have not had any experience with this battery and do not know the name of the maker. If this battery is reliable your electrical dealer should be able to furnish you with information on request.

1910. **Majorana Microphone.** B. F., Modesto, Cal., asks: (1) Could you give me data for making a Majorana microphone, capable of carrying 15 to 20 amperes, like the one mentioned in the article "Progress in Wireless Transmission of Speech," in the November, 1912, number of *Electrician and Mechanic*, or the names and addresses of companies that manufacture Majorana and Dublier microphones. (2) Could No. 4 B.&S. gauge aluminum wire be used in winding the Blitzen type oscillation transformer, instead of the edgewise copper strip, and give good results? How far apart should the wire be spaced? (3) Would a silver dollar, melted and molded into two cylindrical solids in form, be sufficient as contact points on a large key, which is to be connected up with a transformer using 1 k.w. of current? If not, how much silver should be used? Ans.—(1) The apparatus of Majorana and Dublier is as yet in the process of development, and is not upon the market to our knowledge. Until it is, no authentic data can be secured. Its action is based upon the fact that a stream of water falling from an elevated vessel through a small orifice may have its uniformity modified by extremely minute mechanical jars imparted to the containing vessel. The device is actually a liquid transmitter, and is designed to take advantage of this property. The containing vessel terminates at its lower end in a small hole through which water is allowed to flow continually in the form of a minute stream. Interposed in the path of this stream is a small gap. Means, in the form of a thin diaphragm introduced as a portion of the wall of the containing vessel, are provided to affect the diameter and contour of the stream in accordance with the vibrations of the voice. The center of this diaphragm is connected by a light rod to the center of another diaphragm, which is acted upon by the voice through a suitable mouthpiece. The vibrations of the double diaphragm are communicated to the volume of liquid in the form of variations of pressure manifested at the orifice and resulting in similar variations in the volume of water constituting the stream. Such modifications of the stream produce at its juncture with the platinum electrodes of the aerial corresponding variations in the resistance of the gap. It is obvious that this action produces corresponding variations in the intensity of the radiations. (2) Yes; but its efficiency will not compare with that of the copper strip. Keep a 5/16 in. space between the turns. (3) Yes. Brass also is nearly if not quite as good for your purpose. The main point is to keep the contact faces smooth, bright and absolutely parallel.

1911. **Inductive Telephone.** J. J. H., Norfolk, Va., asks: In your issue of November, 1912, in an article on "Progress in Wireless Transmission of Speech," the article states, "By employing coils of sufficient size and suitable microphones, speech can be transmitted over several yards, while by replacing the coils with cables, each end of which terminates in an earth plate, it has been possible to transmit clear speech over a distance of about thirteen kilometers." Please give directions for Inductive telephone to cover distance of two miles. Ans.—The article you refer to was written merely for the purpose of describing the results obtained from some of the more recent experiments in radio-telephony. We regret that our space here is entirely too limited to attempt even general directions for the construction of an instrument such as you suggest. Unless you have an unlimited amount of direct current of high potential at your disposal, 500 volts at least and preferably higher, the results obtained would probably be very unsatisfactory to you. Again, unless you are thoroughly familiar with the handling of high voltages, do not attempt it.

1912. **Wireless Aerial.** R. H. S., Burlington, Vt., asks: (1) What is the better place for an aerial? (2) How should I construct it (number of strands; where inlet should be connected)? (3) Could I receive 200 to 300 miles with a standard equipment? N.B.—There is a difference of 200 ft. or more in elevation. Ans.—(1) On the house. (2) Read some book on this subject. The forms of aerials are about as numerous as the persons who construct them. (3) Yes.

1913. **Small Dynamo.** W. R. P., Saginaw, Mich., proposes to make a machine of the Edison type of field magnet, for an output of 8 volts and 6 amperes, speed being 2,500 revolutions per minute. Magnet cores are to be 3½ in. long, ¾ in. diameter, magnet yoke 4½ x 1½ x ⅝ in. Armature is 2¼ in. diameter, 1½ in. long, with 12 round holes, each ⅜ in. diameter. He asks what the winding should be? Ans.—You will have better proportions in the field magnet and get a larger electrical output if you will make the cores 1¼ in. in diameter; also, if you have plenty of sheet iron punchings, let the armature core be longer, say 2 in. Put No. 19 d.c.c. wire on armature—about 36 wires per slot—18 turns per coil—and connect to a 12-segment commutator. On field magnets put 3 lbs. —1½ per spool—of No. 21 s.c.c. wire.

1914. **Dynamo for Small Lighting Plant.** C. H., Cleveland, Ohio, proposes to make a 4-hole 20-volt dynamo for incandescent lighting, to be used in connection with storage batteries. He proposes an armature 4½ in. diameter, 3 in. long, with 25 slots, series wound. Commutator is to have 1 in. face. Field magnet has poles of sheet iron, 3 x 2 in. face, and 3 in. long, cast into an iron yoke of ¾ in. thick, 9½ in. inside diameter. He asks what the winding should be. Ans.—The armature teeth should be slender, therefore highly saturated with magnetism. Let slots be 28 in. wide and ⅝ in. deep, leaving about 22 in. width inside of insulation. Eight No. 11 d.c.c. wires will fit in them—2 wide and 4 deep. You intend, of course, to wind the coils on a form and then lay them in place, as in case of regular armatures for 4-pole field magnets. For field magnet poles, if you can make iron 2⅛ in. instead of 2 in., it will be better. In connection with storage batteries a plain shunt winding is preferable to compound. Let it consist of No. 15 s.c.c. wire, 5 lbs. or more per spool—all you can get on. The current allowable from armature can be 30 amperes, and your proposed commutator is too short, or else you must use brushes in all four places. Speed can be about 1,500 revolutions per minute.

1915. **Induction Motor.** N. O. W., St. Louis, Mo., says: I have a ⅛ h.p. Westinghouse induction motor of the following style and dimensions: Style No. S.O. 466119—110 volts, 133 cycles, 2,500 revolutions per minute, single phase, squirrel-cage rotor, 48-slot stator, inside diameter 315/16 in., outside diameter 7 in., depth of slot ⅞ in.; thickness of core, 1¼ in. The winding was around three teeth, 18 turns, five and seven teeth, 27 turns of No. 17 d.c.c. wire for the main; and around five teeth, 20 turns, seven teeth, 40 turns of No. 27 d.c.c. wire for starting coils, as per sketch. I wish to rewind for 110 volts, 60 cycles, 1,800 revolutions per minute, and as much power as can be had without much heating. How many turns and what size will I have to use and how will windings be distributed? Ans.—To adapt winding for the lower frequency you will need about 25 per cent. more turns in each circuit—main and starting, as at present. To give the desired speed, the grouping should be for four holes in place of six. If you will number the stator slots 1 to 48, you can wind one starting coil that will fully occupy slots 1 and 11, and half occupy slots 48 and 12; similarly full coils for slots 13 and 23, 25 and 35, 37 and 47, and half coils in slots 12 and 24, 24 and 36, 36 and 48. A main coil can occupy slots 5–7, 4–8, 3–9 and 2–10, omitting slot 6; a second coil will fill slots 17–19, 16–20, 15–21 and 14–22, omitting slot 18; coil 3 will occupy slots 29–31, 28–32, 27–33 and 26–34, omitting slot 30; finally, coil 4 will occupy slots 41–43, 40–44, 39–45 and 38–46, omitting slot 42. (*a*) As you have not given width of slot, we cannot state proper size of wire to use. (*b*) The connections for closing and opening the starting coil circuit can be as at present.

1916. **Machinist.** H. B. N., Shelby, S. Dak., asks: (1) Where small machine tools and supplies can be obtained. (2) Has the Allis-Chalmers Co. in Milwaukee an apprentice course for those desiring to become machinists? Ans. (1) There ought to be numerous dealers in Omaha, and a letter directed to the postmaster there might supply you with the names. Also, C. A. Strelinger, of Detroit, Mich., makes a specialty of machinists' supplies. (2) Yes, but various other large concerns have similar courses. We would advise you to correspond with the General Electric Company, at their headquarters at Schenectady, N.Y., or at the Fort Wayne, Ind., works. In the erecting and care of a great variety of machinery, Swift & Co., of Chicago, are inviting young men to train in their employ. Do not worry as to the lack of the name of proper official. Address your letter to the Apprentice Department of the company and it will bring you a ready answer.

1917. **Logarithmic Decrement.** F. F., Brooklyn, N.Y., says: Your answer to my first question does not clear up my difficulties, for you merely state that the first decrement must be multiplied by two in order to obtain the correct decrement, however giving no reasons for doing so, further than saying that the first is per one-half and the second per full period; but this is not sufficient to make clear the impediment. The answer to my second question is not very comprehensible, but you say, in postscript, that a more extensive explanation will be given in the January issue, and I will await its receipt. I suggest that, if necessary, you introduce higher mathematics in order to elucidate. Ans.—We cannot possibly understand why you want a long mathematical discussion of a thing which does not require it. You are perfectly right in taking the decrement per half period and stopping there. There is no need of going further, since the value per half period is as correct as the value per complete period. If you are at all familiar with the "Principles of Electric Wave Telegraphy and Telephony," by J. A. Fleming, you will be well aware of the fact that if there is a possible chance for him to use his Calculus or Vector Analysis he does so, but this is the manner in which he answers your question: "Some writers define the logarithmic decrement to be the Napierian logarithm of the ratio of two successive oscillations in the same direction that is separated by one whole period. In that case the symbol taken for it is equivalent to 2δ as used above."—Chapter 1, Section 1, page 4, edition of 1912.

TRADE NOTES

The Peck, Stow & Wilcox Company of Southington, Conn., Cleveland, Ohio and New York City have recently issued a new catalog describing their line of mechanics' hand-tools, which is well worthy of the attention of all dealers. This catalog, known as 12B, is a substantial book, well bound and nicely illustrated and printed. It contains 152 pages and is printed upon paper of fairly light weight, although of good quality permitting high-grade printing. The cover design and title page are attractive, and there is a well-designed advertisement of the complete P.S.&W. line upon the back cover.

In many ways this catalog shows an advance over most books of this kind: It is divided into convenient sections devoted respectively to braces and auger bits; chisels, gouges and drawing knives; steel squares; hatchets and hammers; pliers, wrenches; tinners' hand-shears or snips; and miscellaneous hand tools. One of the things which impresses one in looking over these pages is the great extent and variety of the P.S.&W. line. In fact, the makers claim that it is the largest line of mechanics' hand tools offered by any manufacturer. The various sections are each preceded by a designed title page, and a special introduction calling attention to the interesting features of that particular group of tools. There is also a general introduction to the book, giving a great deal of useful information to the hardware dealer.

This is one of the very few cases to our knowledge where a manufacturer has thus included in his catalog practical information and selling talk for the benefit of the jobber and dealer who handle the goods. A strong argument is also included for the advantages of a line of guaranteed tools, each of which bears the trade-mark of the manufacturer as a protection to the distributor, dealer and user. The book is preceded by a complete index, and it contains several pages of advertising matter calling attention to other lines manufactured by the Peck, Stow & Wilcox Company. Among items of special interest to the hardware dealer are the P.S.&W. Samson Brace with ball-bearing chuck; Samson Solid-Center, Single Twist Auger Bits; P.S.&W. Expansive Auger Bit; the very large and complete line of P.S.&W. Chisels, Gouges and Drawing Knives; P.S.&W. Rafter-Framing Square, and Samson Take-Down Square; a very extensive line of box-joint and lap-joint pliers and splicing clamps; and a solid-handle wrench made in but three pieces, excepting the wood facing of the handle.

BOOK REVIEWS

Soldering and Brazing. By James F. Hobart, M.E. New York, Van Nostrand Co., 1912. Price, $1.00 net.

Soldering is one of the subjects of perennial interest to all persons having mechanical tastes. There are already a number of books on the subject, mostly low-priced, but the present or brazing of any description which is not thoroughly covered. The descriptions are simple and workmanlike, and the illustrations are numerous and helpful.

Elbow Patterns for All Forms of Pipe. A Treatise upon the Elbow Pattern, explaining the most Simple and Accurate Methods for Obtaining the Patterns for Elbows in all Forms of Pipe made from Sheet Metal. By F. S. Kidder. Published by The Sheet Metal Publication Co., New York, 1912. Price, $1.00 net.

One of the most difficult tasks for the average sheet metal worker is the construction of elbows for pipes of various shapes and sizes, and the man who can cut a pattern for any special job is one whose merits are always recognized. The draftsman who is versed in descriptive geometry, of course, has no difficulty in laying out such patterns, but the average workman is not an expert in this somewhat dry subject, and to him this book, with its quick and often empirical methods, will prove extremely valuable. It covers the subject thoroughly.

Mission Furniture. How to Make It. Part III. Chicago, Popular Mechanics Co. Price, 50c.

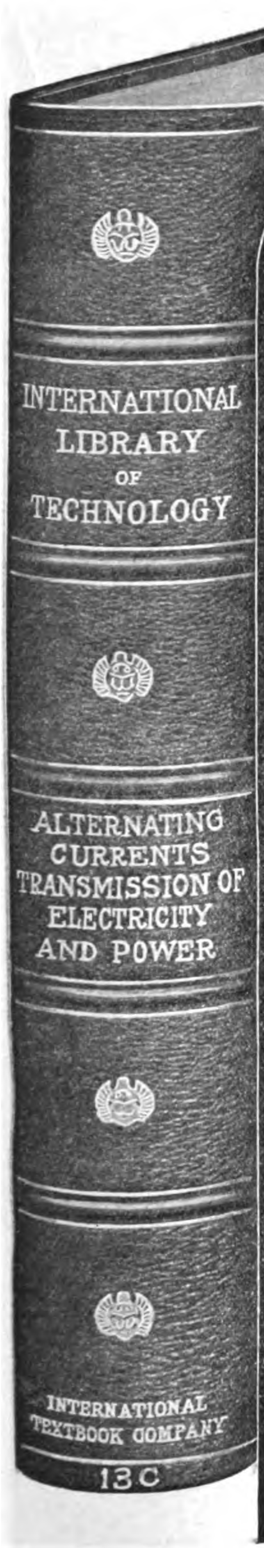
Like the two previous books on the same subject, this is a reprint of designs for various articles of easily made furniture which have already appeared in *Popular Mechanics.* Like all the books of this series, it is extremely good value for the money.

Brasses. By J. S. M. Ward, B.A., F.R.Hist.S., New York, G. P. Putnam's Sons, 1912.

The subject of this excellent little manual is monumental brasses, which are common upon tombs, especially in England, though also found elsewhere in Europe. The subject is of considerable artistic and archaeological interest, and the present manual gives an excellent treatment. The author has made his classifications rather by historical periods than in the earlier fashion of classifying by subjects, and in this way has been able to shed new light upon the subject. The index contains an excellent and valuable list of English brasses.

Alternating Current Machinery. A practical treatise on alternating-current principles and systems, commercial types of alternators, synchronous motors, transformers, convertors, induction motors, switchboard and station appliances, etc. By William Esty, S.B., M.A. Chicago, American School of Correspondence, 1912. Price, $3.00.

Professor Esty, who is head of the Department of Electrical Engineering at Lehigh University, has long been recognized as an authority on the subject of alternating current machinery and his writings have enjoyed a well-deserved popularity. We are, therefore, glad to see this new book on the subject by him, which is fully revised and almost entirely rewritten, using as a basis the similar book previously published by the same publishers. It is unnecessary for us to give a detailed description of the book.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What Others Say About
"INVESTING FOR PROFIT"

Ludlowville, N.Y., August 31, 1911.

H. L. Barber & Co., Chicago, Ill.,

Gentlemen: "Investing for Profit" has come to my desk, a few days ago, and I have 2,164 volumes of books, and I must confess no book has so interested me as *yours*. I spent *three nights* faithfully till 2 o'clock in the morning, and it was hard to let go of it. There is more good, sound *logic* and good common sense in a few *pages* than I have ever seen or read. Anyone having a dollar to spare should take the advice of you. Had I had your book twenty years ago I should be able to take my comfort in *old age*. I shall take the opportunity now open, even in my advanced age in life—*seventy years*—and *invest*. Am a retired Baptist minister, living at Lake Ridge, N.Y., P.O., Ludlowville, N.Y. I have a beautiful home, 16-room house, barn, etc., along Cayuga Lake, one mile from station, twelve miles from Ithaca, N.Y. There is not a day but what you can see from forty to sixty autos go by. Am along the main road, not one inch of waste land, level, and the very best of soil. Your book has so taken hold of me that I cannot let it go. You will hear from me again.

Yours very truly,

C. F. W.

Wonder, Nev., September 4, 1911.

H. L. Barber & Co., Chicago, Ill.,

Gentlemen: Your book "Investing for Profit" to hand, and, on examination I find it to be a most meritorious work—a book that should be in the hands of every investor and prospective investor in the land. One article alone, "The Science of Investment," is worth more than twenty-five years' subscription to the work.

Yours truly,

H. F. A.

Peru, Ind., September 3, 1911.

Mr. H. L. Barber, Chicago, Ill.,

Dear Sir: In response to my card of recent date your most valuable magazine, "Investing for Profit," has been duly received.

I want to say the contents have been the most interesting reading I have had in many a day. I feel in absolute harmony with the sentiment and facts expressed therein, and the opportunities which you point out set my blood boiling.

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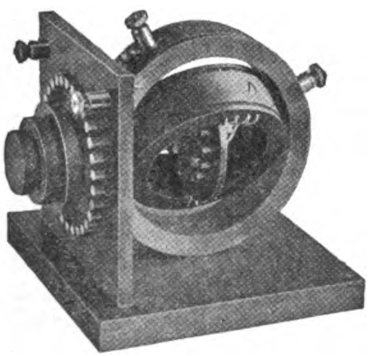

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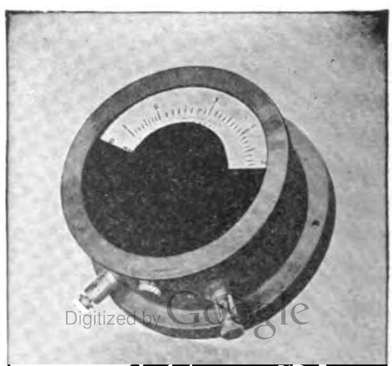

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ELECTRICIAN & MECHANIC

VOLUME XXVI FEBRUARY, 1913 NUMBER 2

THE CALCULATION OF INDUCTANCE

A. S. BLATTERMAN

The function of inductance in high-frequency circuits, especially as applied to radiotelegraphy, is now rather well understood. The fact that it is one of the governing features in the determination of the frequency of oscillation (and necessarily of wave-lengths) has been pointed out before; and this relation has been repeatedly and explicitly shown by publishing the well-known formula:

$$\text{Wave-length} = 2 \times 3.1416 \times V \times \sqrt{LC}$$

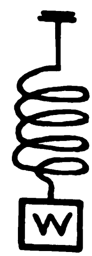
where V = the velocity of light, L = the inductance and C the capacity in the circuit.

It seems never to have occurred to the authors of these articles, or if it has they have failed to meet the difficulty, that this formula is absolutely useless to the average experimenter in regard to any actual practical determinations; for, while he may be able to determine the value of capacity, and discover the velocity of light, there still remains the inductance to be calculated, which he finds is a thing quite beyond him with his available references.

It is in view of this fact, that articles on the calculation of this important factor, inductance, are at best a rarity, that the author has undertaken the methods of determining it for the several forms of circuits most met with in wireless telegraphy.

The inductance of an electric conductor may be defined as that quality of it in virtue of which magnetic energy is stored up in connection with the circuit in which a current is flowing. The practical unit of its measurement is called magnetic flux of 10^8 lines when a current of 1 ampere flows through it.* This is simply definition and its only purpose is to point out that the phenomenon is magnetic in character.

The dimension of an inductance on the electromagnetic system of measurement is a length. Hence the absolute unit of inductance in the electromagnetic system of measurement and in the C.G.S.

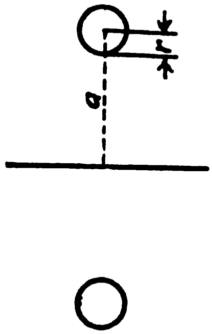


system is 1 centimeter. One henry is equal to 10^9 cms. and one millihenry to 10^6 cms.

In this article we shall be chiefly concerned with the measurement of small inductances which are conveniently measured in centimeters or else in millihenrys.

All conductors must have inductance, or, as it is sometimes called, self-induction, because all currents are surrounded by magnetic fields produced by the currents. An electric current cannot exist without producing a magnetic field, and the production of this field creates an e.m.f. in the circuit in the opposite direction to the e.m.f. driving the causing current. This back voltage of course tends to decrease the effects of the original current. The whole effect is exactly analagous to the property of inertia in mechanical considerations. Let us suppose a weight

spring may be compared to an electrical circuit. The weight possesses inertia, corresponding to the inductance of the electrical circuit, and the dimensions of the spring govern the effects produced by the inertia of the weight, exactly as do the dimensions and form of a conductor in an electrical circuit govern the inductance and its effects in the circuit. If the spring be made longer, other things being kept constant, the time required for the weight to oscillate from its highest to its lowest position will be increased, and *vice versa*. The same holds true in the case of an oscillatory electric circuit. If the inductance coil is made larger, the time period of the circuit is increased; and if the inductance coil is made smaller, the time period is diminished.



A great many formulas have been given for calculating the self-inductance of the various cases of electrical circuits occurring in practice. Some of these formulas have been shown to be wrong, and of those which are correct and applicable to any given case there is usually a choice, because of the greater accuracy or greater convenience of one as compared with the others. Of course, this article being restricted as to space, and also to radiotelegraphic relations, omits all but a very few of these formulas, and those which are discussed have been chosen, following their extended use by the author, on account of their merit.

The first case of importance occurring in practice is that of a straight cylindrical wire whose length is l, and whose diameter is d. Both of these dimensions are in centimeters. The inductance of such a conductor is given by the formula

$$(1) \quad L = 2 \times l\left(2.3026 \log_{10} \frac{4 \times l}{d} - 1\right)$$

Thus suppose we have a straight cylindrical wire 100 ft. long and .1 in. in diameter. These dimensions reduced to centimeters are

$$l = 100 \times 30.48 = 3048 \text{ cm.}$$
$$d = .1 \times 2.54 = .254 \text{ cm.}$$

Substituting these values in the above formula

$$L = 2 \times 3048 \left(2.3026 \log_{10} \frac{4 \times 3048}{.254} - 1\right)$$
$$= 6096\,(2.3026 \times 4.68124 - 1)$$
$$= 59611.0 \text{ cm., or } 0.0596 \text{ mh.}$$

The second form of circuit occurring very frequently is that of a circle. This is quite often one turn of a sending helix. The formula for calculating the inductance of such a circle is

$$L = 4 \times 3.1416 \times a \left\{ \left(1 + \tfrac{3}{16}\frac{r^2}{a^2}\right) \log_e \frac{8a}{r} - \frac{r^2}{16a^2} - 2 \right\}$$

which can be put into the form

$$(2) \qquad L = 4 \times 3.1416 \times a \left\{ 2.3026 \left(1 + \tfrac{3}{16}\frac{r^2}{a^2}\right) \log_{10} \frac{8a}{r} - \frac{r^2}{16a^2} - 2 \right\}$$

When r = radius of wire in centimeters.
Where a = radius of circle in centimeters. See Fig. 2.

Suppose it is desired to determine the inductance of one turn of a sending helix whose dimensions are $a = 15$ cms. and $r = .3$ cms. Formula (2) enables us to compute the inductance of the circle by substituting the given values of a and r.

$$L = 4 \times 3.1416 \times 15 \left\{ 2.3026 \left(1 + \tfrac{3}{16}\frac{.09}{225}\right) \log_{10} \frac{120}{.3} - \frac{.09}{16 \times 225} - 2 \right\}$$

The best way of carrying out the indicated computations is to use logarithms to at least five places.

$$\frac{.09}{16 \times 225} = ?$$

$$\begin{array}{lcl} \text{Log } .09 & = & 8.95424-10 \\ \text{Colog } 16 & = & 8.79588-10 \\ \text{Colog } 225 & = & 7.64782-10 \\ \hline & & 25.39794-30 \end{array}$$

$$\frac{.09}{16 \times 225} = .000025$$

$$\text{Log}_{10}\frac{120}{.3} = \log_{10} 400 = 2.60206$$

$$\text{Log } 1.000075 = 0.00003$$

$$\left(1 + \tfrac{5}{16} \times \frac{.09}{225}\right) = 1.000075$$

$$\begin{array}{lcl} \text{Log } 2.3026 & = & 0.36222 \\ \text{Log } 2.60206 & = & 0.41532 \\ \hline & & 0.77757 \end{array}$$

$$2.3026\left(1 + \tfrac{5}{16} \times \frac{.09}{225}\right) \log_{10}\frac{120}{.3} = 5.9920$$

$$\left\{2.3026\left(1 + \tfrac{5}{16} \times \frac{.09}{225}\right) \log_{10}\frac{120}{.3} - \frac{.09}{16 \times 225} - 2)\right\} =$$

$$5.9920 - 0.000025 - 2 = 3.991975$$

$$\begin{array}{lcl} \text{Log } 4 & = & 0.60206 \\ \text{Log } 3.1416 & = & 0.49175 \\ \text{Log } 15 & = & 1.17609 \\ \text{Log } 3.991975 & = & 0.60118 \\ \hline \text{Log } L & = & 2.87648 \\ L & = & 752.45 \text{ cms.} \end{array}$$

THE SELF-INDUCTANCE OF SINGLE LAYER COILS

By far the most important and most frequently encountered circuits in radio-telegraphic work are those in which the wire is wound in the form of single layer solenoids. This construction is adhered to almost without exception, both in the transmitting circuits and in the receiving circuits, and a means of determining the inductance of such coils is important. It is understood that this article deals only with air core coils such as are used only in direct connection with the high-frequency oscillatory elements of the apparatus. More particularly, it concerns the calculation of the inductance of helices, tuners, loading coils, wavemeters, etc.

The following formulas and tables will be found to be quite convenient for the forms of circuits under consideration and will yield very accurate results. I shall first give the formulas and the tables pertaining to them together with an explanation of their use, and afterwards will take up definite examples to illustrate thoroughly the calculations and methods involved.

The following formula and tables are due to Nagaoka:

$$L_s = 4 \times 3.1416^2\, a^2\, n^2 b\, K \qquad (3\ )$$

Where

a = radius of solenoid to center of wire in centimeters.

n = number of turns of wire per centimeter length of coil.

b = length of coil in centimeters.

K = a constant (to be obtained from following table).

TABLE I

Nagaoka's Table of Values of the End Correction K as a Function of the Ratio $\frac{Diameter}{Length}$

Diam./Length	K	D_1	D_2	Diam./Length	K	D_1	D_2
0.00	1.000000	-4231	24	.24	.905290	-3641	25
.01	.995769	-4207	26	.25	.901649	-3616	23
.02	.991562	-4181	24	.26	.898033	-3593	24
.03	.987381	-4157	25	.27	.894440	-3569	23
.04	.983224	-4132	25	.28	.890871	-3546	24
.05	.979092	-4107	25	.29	.887325	-3522	24
.06	.974985	-4082	26	0.30	.883803	-3498	22
.07	.970983	-4056	24	.31	.880305	-3476	24
.08	.966847	-4032	24	.32	.876829	-3452	23
.09	.962815	-4008	26	.33	.873377	-3429	23
0.10	.958807	-3982	25	.34	.869948	-3406	22
.11	.954825	-3957	24	.35	.866542	-3384	24
.12	.950868	-3933	23	.36	.863158	-3360	22
.13	.946935	-3910	26	.37	.859799	-3338	23
.14	.943025	-3884	27	.38	.856461	-3315	22
.15	.939141	-3857	23	.39	.853146	-3293	23
.16	.935284	-3834	23	0.40	.849853	-3270	22
.17	.931450	-3811	26	.41	.846583	-3248	23
.18	.927639	-3785	24	.42	.843335	-3225	21
.19	.923854	-3761	24	.43	.840110	-3204	21
0.20	.920093	-3737	24	.44	.836906	-3183	23
.21	.916356	-3713	24	.45	.833723	-3160	21
.22	.912643	-3689	25	.46	.830563	-3139	22
.23	.908954	-3664	23	.47	.827424	-3117	21
.24	.905290	-3641	25	.48	.824307	-3096	21
.49	.821211	-3075	21	.76	.745191	-2554	17
0.50	.818136	-3054	21	.77	.742637	-2537	18
.51	.815082	-3033	21	.78	.740100	-2519	17
.52	.812049	-3012	21	.79	.737581	-2502	16
.53	.809037	-2991	20	0.80	.735079	-2486	19
.54	.806046	-2971	21	.81	.732593	-2467	16
.55	.803075	-2950	20	.82	.730136	-2451	16
.56	.800125	-2930	20	.83	.727675	-2435	16
.57	.797195	-2910	20	.84	.725240	-2419	17
.58	.794285	-2890	20	.85	.722821	-2402	16
.59	.791395	-2870	20	.86	.720419	-2386	16
0.60	.788525	-2850	19	.87	.718033	-2370	15
.61	.785675	-2831	19	.88	.715663	-2355	16
.62	.782844	-2812	20	.89	.713308	-2339	17
.63	.780032	-2792	19	0.90	.710969	-2322	14
.64	.777240	-2773	19	.91	.708647	-2308	16
.65	.774467	-2754	19	.92	.706339	-2292	15
.66	.771713	-2735	19	.93	.704047	-2277	16
.67	.768978	-2716	19	.94	.701770	-2261	14
.68	.766262	-2697	18	.95	.699509	-2247	15
.69	.763565	-2679	18	.96	.697262	-2232	15
0.70	.760886	-2661	18	.97	.695030	-2217	15
.71	.758225	-2643	19	.98	.692813	-2202	14
.72	.755582	-2624	17	.99	.690611	-2188	14
.73	.752958	-2607	18	1.00	.688423	10726	344
.74	.750351	-2589	18	1.05	.677697	-10382	330
.75	.747762	-2571	17	1.10	.667315	-10052	316
.76	.745191	-2554	17	1.15	.657263	-9736	303
1.20	.647527	-9433	290	3.10	.421687	-7219	275
1.25	.638094	-9143	278	3.20	.414468	-6944	260
1.30	.628951	-8865	266	3.30	.407524	-6684	245
1.35	.620086	-8599	255	3.40	.400840	-6439	230
1.40	.611487	-8343	244	3.50	.394401	-6209	220
1.45	.603144	-8099	236	3.60	.388192	-5989	207
1.50	.595045	-7863	224	3.70	.382203	-5782	195
1.55	.587182	-7639	215	3.80	.376421	-5587	186
1.60	.579543	-7424	208	3.90	.370834	-5401	174
1.65	.572119	-7216	198	4.00	.365433	-5227	168
1.70	.564903	-7018	190	4.10	.360206	-5059	161
1.75	.557885	-6828	184	4.20	.355147	-4898	152
1.80	.551057	-6644	176	4.30	.350249	-4746	141
1.85	.544413	-6468	170	4.40	.345503	-4605	138
1.90	.537945	-6298	161	4.50	.340898	-4467	134
1.95	.531647	-6137	154	4.60	.336431	-4333	125
2.00	.525510	-11809	580	4.70	.332098	-4208	118
2.10	.513701	-11229	539	4.80	.327890	-4090	115
2.20	.502472	-10690	499	4.90	.323800	-3975	102
2.30	.491782	-10191	465	5.00	.319825	-18321	2227
2.40	.481591	-9726	434	5.50	.301504	-16094	1830
2.50	.471865	-9292	405	6.00	.285410	-14264	1524
2.60	.462573	-8887	378	6.50	.271146	-12740	1283
2.70	.453686	-8509	355	7.00	.258406	-1145[illegible]	1090
				7.50	.246949	-1036[illegible]	937

TABLE II

Values of Correction Term "A," depending on the ratio $\frac{d}{P}$ *of the Diameters of Bare and Covered Wire on the Coil*

$\frac{d}{P}$	A	$\frac{d}{P}$	A	$\frac{d}{P}$	A
1.00	0.5568	.80	0.3337	.60	0.0460
.99	.5468	.79	.3211	.59	.0292
.98	.5367	.78	.3084	.58	.012[illegible]
.97	.5264	.77	.2955	.57	−.0053
.96	.5160	.76	.2824	.56	−.0230
.95	.5055	.75	.2691	.55	−.0410
.94	.4949	.74	.2557	.54	−.0594
.93	.4842	.73	.2421	.53	−.0781
.92	.4734	.72	.2283	.52	−.0971
.91	.4625	.71	.2143	.51	−.1165
.90	.4515	.70	.2001	.50	−.1363
.89	.4403	.69	.1857		
.88	.4290	.68	.1711	.50	−.1363
.87	.4176	.67	.1563	.45	−.2416
.86	.4060	.66	.1413	.40	−.3594
.85	.3943	.65	.1261	.35	−.4928
.84	.3825	.64	.1106	.30	−.6471
.83	.3705	.63	.0949	.25	−.8294
.82	.3584	.62	.0789	.20	−1.0526
.81	.3461	.61	.0626	.15	−1.3403
.80	.3337	.60	.0460	.10	−1.7457

K is a function of the ratio of the diameter of the coil in question to its length, and in the determination of K for any particular case the method of procedure is as follows:

Measure b, the length of the coil, and $2a$, its diameter, dividing the latter by the former and finding the decimal equivalent of the ratio $\frac{2a}{b}$. In the table look under the column headed "$\frac{\text{Diameter}}{\text{Length}}$" for the decimal just found, and in the same horizontal line and under the column headed "K," find the required value of K. It will always be less than 1. In the event that the value of the ratio $\frac{2a}{b}$ lies between two of the values given in the table, the value of K may be found by interpolation for which purpose columns "D_1" and "D_2" are given. The interpolation formula to be used is

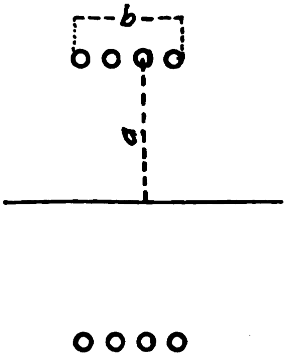
$$K = K_1 + cD_1 + \frac{c(c-1)D_2}{2}$$

where K is the value sought. K_1 is the value of K given in the table corresponding to the value of the ratio $\frac{2a}{b}$ next lower

$$L_s = 4 \times 3.1416 \times a \times n^2 \left\{ 2.3026 \log_{10} \frac{8 \times a}{b} - \frac{1}{2} + \frac{b^2}{32a^2} \left(2.3026 \log_{10} \frac{8a}{b} - \frac{1}{4} \right) \right\}$$

h is the remainder above the value of the ratio $\frac{2a}{b}$ given in the table, and d is the increase in the value of the same ratio given in the table. D_1 and D_2 are found opposite the value of $\frac{2a}{b}$ just lower than the true value. A definite illustration of the use of this formula will be given later in the solution of a complete problem.

The above formulas and tables are most satisfactory for the determining of the inductance of coils longer than about one-fifth of their diameter. For shorter solenoids the following formula should invariably be used. It is adaptable to helices and may even be used to compute the inductance of a single turn of wire with the greatest accuracy. It is due to Rayleigh and Niven, and is as follows:



Where
n=whole number of turns,
a=the radius in centimeters.
b=the length in centimeters (see figure).

The self-inductance L_s is, however, not the actual self-inductance of the coil, but what is called the current sheet value; that is, it is the value of the self-inductance if the winding were of infinitely thin tape, so that the current would cover the entire length b. To get the actual self-inductance L for any given case it is necessary to correct L_s by the next formula.

It has been shown that the above two formulas, *viz.*, (3) and (4), apply accurately only to a winding of infinitely thin strip which completely covers the solenoid (the successive turns being supposed to meet at the edges without making electrical contact) and so realizing a uniform distribution of current over the surface. A winding of insulated wire or of bare wire wound in a screw thread may have a greater or less self-inductance than that given by the current sheet formulas above, according to the ratio of the diameter of the wire to the pitch of the winding. Putting L for the actual self-inductance of a winding and L_s for the current sheet value given by one of the above formulas,

$$L = L_s - DL$$

The correction DL is given by the following expression:

$$DL = 4 \times 3.1416 \times a \times n \; (A + B)$$

where a=radius in centimeters, and n= whole number of turns, and A and B are constants given in Tables II and III.

The correction term A depends on the size of the bare wire (of diameter d) as

TABLE III

Values of the Correction Term "B," depending on the Number of Turns of Wire on the Single Layer Coil

No. of Turns	B	No. of Turns	B
1	0.0000	50	0.3186
2	.1137	60	.3216
3	.1663	70	.3239
4	.1973	80	.3257
5	.2180	90	.3270
6	.2329	100	.3280
7	.2443	125	.3298
8	.2532	150	.3311
9	.2604	175	.3321
10	.2664	200	.3328
15	.2857	300	.3343
20	.2974	400	.3351
25	.3042	500	.3356
30	.3083	600	.3359
35	.3119	700	.3361
40	.3148	800	.3363
45	.3169	900	.3364
50	.3186	1000	.3365

compared with the pitch P of the winding; that is, on the value of the ratio $\frac{d}{P}$. For values of $\frac{d}{P}$ less than 0.58, A is negative, and in such cases when the numerical values of A are greater than those of B, which is always positive, the correction DL will be negative, and hence L will be greater than L_s. The use of the tables II and III will be understood from the examples illustrating formulas (4) and (3), which, as above stated, also suffer correction.

EXAMPLES

Example 1

Nagaoka's formula.

$$L_s = 4\pi^2 a^2 n^2 b K$$

let $a = 27$ cms.
$b = 32$ cms.
$h = 10$ turns per centimeter.

To find K, first determine $\frac{2a}{b}$.

$\frac{2a}{b} = \frac{54}{32} = 1.6875$, and looking in Table I under column $\frac{2a}{b}$, we find that 1.6875 lies between the values 1.65 and 1.70 in the table.

Referring now to the interpolation formula

$$K = K_1 + cD_1 + \frac{c(c-1)D_2}{2},$$

we have the following substitutions to make

$K_1 = .572119$ $\quad c = \frac{h}{d} = \frac{1.6875 - 1.65}{1.70 - 1.65} = \frac{.0375}{.05}$

$D_1 = -7216$

$D_2 = +198$ $\quad c = .75$

whence $K = .572119 - (.75 \times 7216) + \frac{.75(.75-1)\,198}{2}$

$= .572119 - .005412 - .000018$

$= .566689$

So that $L_s = 4 \times \overline{3.1416^2} \times \overline{27^2} \times 100 \times 32 \times .566689$

$= 52{,}187{,}700$ cms.

This is the current sheet value and must be corrected by formulas (10) and (11). The diameter of the bare wire is $d = .0193$ cms.

$P = .1000$ cms.

$\frac{d}{P} = .913$ and from Table II $A = .4658$

n = whole number of turns = 320

From Table III. $B = .3345$

$DL = 4 \times 3.1416 \times 27 \times 320 \times (.4658 + .3345)$
$= 86912$ cms.

$L = L_s - DL$
$= 52187700 - 86912 = 52100788$ cms.
or .052100788 henrys,

which is the true value of the inductance.

Example 2

Let us suppose a coil wound with the same kind of wire as that in the previous example. And let its other dimensions be the same with the one exception that b is now 4 cms.

Let us compute the inductance by the formula of Rayleigh and Niven.

$$L_s=4 \times 3.1416 \times 27 \times 1600 \left\{ 2.3026 \log_{10} \frac{216}{4} - \frac{1}{2} + \frac{16}{32 \times \overline{27^2}} (2.3026 \log_{10} \frac{216}{4} + \frac{1}{4}) \right\}$$

$$=4 \times 3.1416 \times 27 \times 1600 \left\{ 2.3026 \times 1.73239 - \frac{1}{2} + \frac{1}{2 \times 729} (2.3026 \times 1.73239 + \frac{1}{4}) \right\}$$

$=4 \times 3.1416 \times 27 \times 1600 \times 3.4919$
$=1,895,480$ cms.
which must be corrected as in the previous example:
$\frac{d}{P}=.913$ as before and $A=.4658$
$h=40$ and from Table III $B=.3148$
$DL=4 \times 3.1416 \times 27 \times 40\ (.4658 + .3148)$
$=10,594$ cms.
$L=L_s - DL=1895480 - 10594=1884886$ cms.

As an extreme test of the accuracy of this formula we may calculate the inductance of a single turn of wire whose dimensions are those given in the example illustrating formula (2) *i.e.*,

$a=15$ cms.
$b=.6$ cms.
$n=1$

Substituting

$$L_s=4 \times 3.1416 \times 15 \left\{ 2.3026 \log_{10} \frac{120}{.6} - \frac{1}{2} + \frac{.36}{32 \times 225} (2.3026 \log_{10} \frac{120}{.6} + \frac{1}{4}) \right\}$$

$$=60 \times 3.1416 \left\{ 2.3026 \times 2.30103 - \frac{1}{2} + \frac{.36}{32 \times 225} (5.5483) \right\}$$

$=904.5$ cms.

Correcting this current sheet value, $\frac{d}{P}=1$,

$A=.5568$ and $B=0$
$DL=4 \times 3.1416 \times 15 \times .5568$
$=104.95$ cms.
$L=L_s - DL=904.5 - 104.95=799.55$ cms.

The value obtained from formula (2) is 752.45 cms. The discrepancy is due to the fact that formula (2) gives the inductance for infinitely high frequencies, while in the above example the value obtained is for very low frequency or, more correctly, for steady currents only. The exact predetermination of the inductance of conductors at high frequency is very complicated—if, indeed, it is possible at all—and only in the simplest forms of circuits can close approximation to the desired value be obtained.

The following formula will serve to correct values of inductance calculated for zero frequency, or direct current to any frequency n, though it is only applicable to copper wires which are straight or very slightly bent. L is the direct current inductance, l is the length, and d the diameter of the conductor (all in centimeters).

$$L_1=L-l\left(½-\frac{40}{3.1416 \times d\sqrt{n}}\right)$$

It is seen that when n becomes very large, the second term in the brackets becomes 0, so that a very approximate correction is applied by simply subtracting from

(*Continued on page* 87)

THE PRODUCTION OF ACCURATE SCREW-THREADS IN THE LATHE
Part II—Testing and Gauging

FRANCIS W. SHAW

Now arises the question of gauging the work, both during progress and after completion. The attainment of accuracy in lead will rest almost wholly on accuracy of machine and alignments. Heating of the work may account for some error; but this is avoidable by allowing the work to cool down before taking final finishing cuts. If the machine guide-screw be accurate in lead and ordinary care is taken at all points, any check needed would be to ascertain accidental slips. An ordinary screw-pitch gauge would be sufficient for this purpose. To check the form of thread before completion it would be impossible to employ standard ring or plug-gauges.

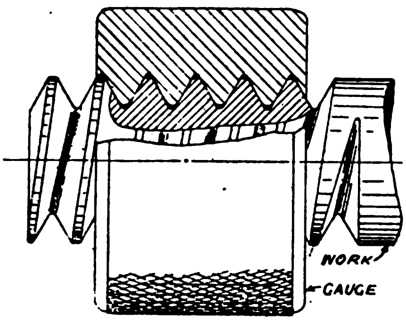


Fig. 11—Showing Clearance at Bottom of Spaces in Ring Gauges to clear Flat Tops of Work Threads

As a final test, these are, of course, useful, and if made as shown in Figs. 11 and 12, they can be used before the final rounding off of the thread, the gauge threads being cut deeper as shown. Previous to rounding off, some form of adjustable gauge is advisable. The Brown & Sharp micrometer (Fig. 13*A*) is a convenient tool, used in the manner shown. It will be noticed that the points are cut away in such a manner that they do not interfere with the tips or roots of the thread. Hence, measurement is made of what is termed the angular diameter of the thread, which is, of course, the part of the thread which should regulate the fit. In this micrometer, when the points are in contact, as shown at *B*, the micrometer reading is at

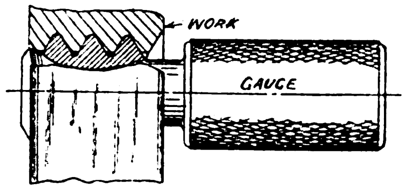


Fig. 12—Showing Clearance at Bottom of Spaces in Plug Gauges to clear Flat Tops of Work Threads

For this reason, an amount equal to twice the addendum must be added to the reading to arrive at the outside diameter. For the Whitworth standard the amount to be added to the reading amounts to 0.640—pitch (p). The following table presents these amounts worked out for the various pitches:

READING OF B.&S. MICROMETER FOR WHITWORTH THREADS

Diameter	Threads per inch	Micrometer Reading	—
d	p	$d - \frac{.640}{p}$	$\frac{.640}{p}$
Inches			
¼	20	.2180	.0320
5-16	18	.2769	.0355
⅜	16	.3350	.0400
7-16	14	.3918	.0457
½	12	.4467	.0533
9-16	12	.5092	.0533
⅝	11	.5668	.0582
11-16	11	.6293	.0582
¾	10	.6860	.0640
13-16	10	.7485	.0640
⅞	9	.8039	.0711
15-16	9	.8664	.0711
1	8	.9200	.0800
1⅛	7	1.0336	.0914
1¼	7	1.1586	.0914
1⅜	6	1.2684	.1066
1½	6	1.3934	.1066
1⅝	5	1.4970	.1280
1¾	5	1.6220	.1280
1⅞	4½	1.7328	.1422
2	4½	1.8578	.1422
2⅛	4½	1.9828	.1422

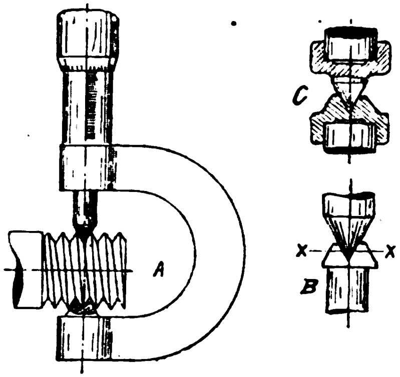


Fig. 13—Measuring Angular Diameter of Screw

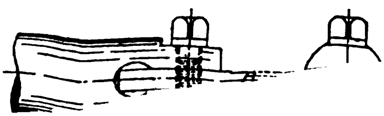
Whitworth form is used on screws of different diameters than standard.

C, Fig. 13, shows attachments for converting an ordinary micrometer. The table of readings may be employed by adding the initial reading of the micrometer when the gauging points are in contact to the tabulated figures.

In screw-cutting the first process will be the cutting of the thread with a V-tool in the manner already indicated. This will leave the top of thread flat. During this process, the diameter will be checked by the thread micrometer, Fig. 13. If tools are sharp, accurate and accurately set, the thread flanks may be accurately finished by the tool itself, nothing being left to be removed by the chaser. If means are not at hand for insuring the necessary tool accuracy, about .005 should be left on the diameter for finishing with the chaser. However, it is recommended that an attempt be made to secure the necessary tool accuracy and avoid chasers, which are apt to be cut out of pitch, due to distortion in hardening.

THREAD ROUNDING

Assuming that the correct angular diameter of the thread being produced



has been attained, all that remains is the rounding of the tip of the thread. To do this a simple tool, easily made, is that shown in Fig. 14. The thread rounder itself is made from rectangular steel, and is held in a holder, as clearly shown. In order to get the radius of the cutting portion correct, a hole, slightly smaller in *radius* than the radius of the thread-tip is drilled near to the end of the short piece of steel, as shown. This hole is countersunk to reduce the depth of the cutting-edge, and so avoid undue interference in use. The cutter is now hardened and tempered to suit the nature of the steel, and the hole lapped out to size with a piece of copper wire charged with diamond dust or emery, to a gauge already prepared by grinding to correct size a

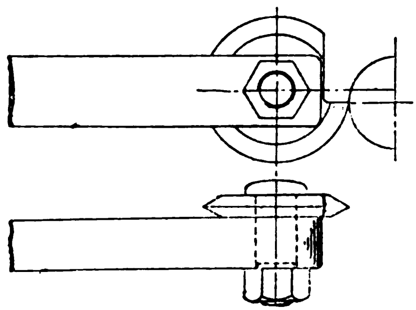


Fig. 15—Circular Threading Tool

piece of hardened steel wire. It is possible at times to make use of a needle or even a piece of music-wire carefully chosen by micrometer measurement for this purpose.

After lapping, the end of the cutter is ground off (note the dotted lines) to the correct angle. At *A* is shown how an internal thread-rounder is prepared. In using these tools, care must be exercised in setting in relation to the thread-angles. This is best done by adjusting the tool sidewise until by the aid of a magnifying-glass the ends of the arc are seen to coincide with the thread-angle. These tools are ground on the top surface only.

of the tool results in a plan shape of elliptical form. The difference from a true circle is, however, quite inappreciable.

CIRCULAR THREADING TOOL

Fig. 15 shows a simple threading tool, whose particular virtues consist in that it is cheaply produced, readily ground and has a long life. It will be noticed that the putting face is below the line of centers to avoid interference with the thread flanks. This may be used for right- or left-hand threads. Where the lead-angle is large, it will be necessary to tilt the tool. If the plan angle of the tool be made slightly less than standard, the resultant thread form will be more nearly correct. For extremely accurate threads this tool will do for roughing out only. This will be apparent from a study of Fig. 9.

Now, let us consider the particular difficulties which beset the Square and Acme thread forms, as shown in Fig. 16. The proportions of these threads are given in the following formulas and table:

Formulas

l=lead=the amount of movement of a nut due to one turn of the screw.

p=pitch=the distance from center to center of adjacent turns of thread. (In a single-threaded screw, $p=l$).

t=thickness of top of thread in an "Acme" thread, and thickness of thread in a square thread.

d=depth of thread.

c=clearance between top of thread in screw and bottom of space in nut, or between bottom of space in screw, and top of thread in nut.

$$\text{Acme } t = \frac{l \times .3707}{\text{number of leads}} = .3707p$$

$$\text{Square } t = \frac{1 \times .5}{\text{number of leads}} = .5p$$

Acme $d = .5p + .010$ in all leads

Square $d = .5p + c$ ...

ACME STANDARD THREADS

Proportion in Inches

Pitch=p	Depth=d	Thickness of Top of Thread =t	Thickness of Bottom of Thread	Width of Top of Space	Width of Bottom of Space
1	.5100	.3707	.6345	.6293	.3655
2	.2600	.1853	.3199	.3147	.1801
3	.1767	.1235	.2150	.2098	.1183
4	.1350	.0927	.1625	.1573	.0875
5	.1100	.0741	.1311	.1259	.0689
6	.0933	.0618	.1101	.1049	.0566
7	.0814	.0529	.0951	.0899	.0478
8	.0725	.0463	.0839	.0787	.0411
9	.0655	.0413	.0751	.0699	.0361
10	.0600	.0371	.0681	.0629	.0319

EFFECT OF SPRING IN TOOLS

In cutting threads of any form, a trouble experienced is that of the commencing portion of the thread being cut rather thicker than normal. This is due to the fact that when the tool first meets the work, the pressure is taken by the leading side of the tool, causing it to yield. Backlash in the slides and inherent

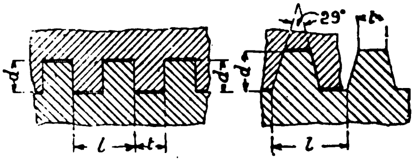


Fig. 16—Square and Acme Standard Threads

weaknesses in the job and the machine tend to the same end. As the tool proceeds in its travel, the other side of the tool receives a pressure tending to balance that on the first entering side, with the result that the tool ultimately returns to its normal position. Thus the lead is a slightly variable one, seen particularly in the case of very fine square or "Acme" threads, where the difference is very acute. The first point needing attention is the tool itself, which should be as still as possible. A square thread tool, made as shown in Fig. 17, will be

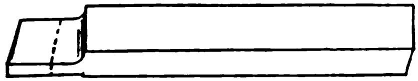


Fig. 17—Square Thread Tool

of the slide-rest should be adjusted so as to move rather stiffly. Again, see that the work itself, if of a flimsy character, be well stayed, and the spindle of the headstock neatly adjusted. One source of trouble is frequently due to lack of care in centering the work. The centers should be deep, and conform in angle to the headstock centers. Then when extreme accuracy is needed, the material in the work must have attention. The removal of metal from the outside of a bar results in the releasing of internal stresses due to the rolling, hammering, or cooling. Hence, as the exterior portion of the material is subject to the most severe of these stresses, ample allowance must be made for machining. Oftentimes it is necessary to release the inherent stresses by a process of annealing prior to screw-cutting, and even after roughing out the thread. The amount of such attention, will, of course, vary with the refinement of accuracy demanded. A point worth noting is that any straightening necessary should be done prior to annealing, and care taken in annealing by careful packing in the furnace—to prevent distortion during this process. Material should also be carefully chosen. Steel of a very soft nature is very "luggy" in the cutting, and there is a great tendency for the tool to seize the material. Such steel may be more readily cut under ample lubricant—lard-oil for preference.

This point of yield in the tool, due to one-sided pressure, is an important one—so important, in fact, that where the work must be accurate, each side of the thread must be cut independently, after initially roughing out—very carefully—with a tool narrower than the space. Not only so, but it is better to feed in the tool at the angle of the thread-flank than to tool is fed direct into the work, the total width of cut as the thread nears completion is considerable. As a consequence of this, the pressure on the tool and the reaction on the work is also considerable; hence, there is a great tendency for both work and tool to yield. The work, as a rule, if frail in structure, mounts the tool, which in common parlance, digs in. This may to some extent be mitigated by using a spring tool, in which any extra pressure forces the tool out of the work. This is the procedure adopted in thread-cutting lathes where the work is done automatically, and in which it would be impossible or impracticable, at least, to make (automatically) the changes in tool position needed to work on the step-by-step lines advocated above. Obviously, a spring tool, if it fulfils its "spring" function, must result in imperfect work. If it does not spring, then it is no better than a non-spring tool.

GRINDING THREADING TOOLS

Much depends on accuracy of tools: hence it will not be out of place to mention some of the methods adopted to insure accuracy. Modern engineering concerns have now abandoned the methods which left the grinding of tools in the hands of the individual workman. A tool-grinding department, whose duty is to dole out the necessary tools, collect and regrind them at intervals, is the regular order of things. This department is now fitted up with special machines, in which tools may be fixed and controlled in their movements in relation to the grinding wheel. Thus, a threading tool either for V, Acme or square threads, would be fixed in a holder and constrained to travel in such a relation to the grinding-wheel as to produce the required angles with precision. Accurate gauges are provided to check not only the angles, but the widths of tools. Attention has been particularly paid to cutting and rake angles. As a rule these machines are accompanied by a board bearing

of slides capable of being tilted to any desired angle to the grinding wheel. The writer has arrived at the same result by mounting tools in an ordinary slide-rest on the lathe, using the swivel to give the necessary angular movements, an emery wheel being mounted between the lathe-centers.

This short description of grinding methods will suffice to give a few hints on the subject. To deal adequately with the subject of grinding tools would need considerable space, and is not really germane to the art of screw-cutting.

In conclusion, the manufacture of accurate screws is by no means a simple affair—the manufacture of precision screws, most difficult. What has been said—although relating to some extent to precision screws—is intended rather to deal with those screws used in machinery—machine tools in particular—for controlling feeds, etc., and to apply to the manufacture of ordinary screwing tackle, and, generally, to screws comparatively short in length. The production of what is termed a precision screw needs methods almost entirely different. The production of a screw, say, 5 ft. long, within a limit of variation in pitch of half a thousandth of an inch per foot is a serious undertaking. As a matter of fact, but two or three firms exist who are capable of tackling such a job.

A Telephone Time Saver

What looks like a good suggestion is a device noted in a recent number of the *Electrician*, an invention designated as a telephone time saver. This device consists of a sound-magnifying trumpet, of flattened form, similar to certain types of motor horns, behind which is a platform adapted to support the telephone receiver. Upon receiving or making a call upon the 'phone and being asked to "hold the line," the user, instead of "holding on" with the telephone receiver pressed to his ear, an arrangement which restricts his movements and prevents him from giving his attention to any other matter, merely drops the receiver onto the platform of the "time saver," where it automatically slides into position with the earpiece against the small end of the spiral trumpet. The user is then free to go on with his work until the voice from the trumpet shows him that the person at the other end is speaking. Conversation can then either be carried on using the loud-speaking trumpet, with the advantage of leaving the user's hands both free for the purpose of turning up references, taking down a message from dictation, etc., or the receiver may be lifted off the instrument and used in the ordinary way. The loud-speaking telephone's "voice" is very similar to that

Bare Aluminum Wires for Coils

The conductivity of aluminum is about 60 per cent. of that of annealed copper. Accordingly, an aluminum conductor must be considerably larger in cross sectional area than a copper conductor if the two are to carry the same amount of current. Aluminum wire is always coated with a thin oxide which serves as an insulator. This insulation is enough, according to some European manufacfacturers, to permit of using bare aluminum wire in the coils of magnets. As the oxide film is of inappreciable thickness, a coil of fine wire thus constructed would be no bulkier, if as bulky, as a coil wound with insulated copper wire. H. F. Stratton, writing on this subject in the *Electrical World*, states that he has been unable to secure sufficient insulation when depending upon the aluminum oxide film as it naturally occurs in the commercial product. In order to increase this oxide, some European manufacturers wet the coil and then heat it. This he thinks hardly sufficient, but he has produced very successful results by passing the wire through sodium hydroxide, and then drying the coil by passing a current through it.

Lady (engaging cook)—"This reference

MECHANICAL DRAWING

P. LEROY FLANSBURG L. BONVOULOIR

ORTHOGONAL PROJECTION

Orthogonal or orthographic projection is a science based on solid and descriptive geometry. It may be best described as the art of representing objects or magnitudes on two or more suitably chosen planes. Usually these planes are taken at right angles to each other and the projection of the object on the planes exactly represent the object by showing its form, dimensions and the relation of its lines and surfaces to each other. The science is of great interest and importance to the draftsman, since upon it are based all architectural and mechanical working drawings.

In mechanical drawing the object is represented on two planes, which are termed the horizontal plane of projection and the vertical plane of projection. These two planes are taken perpendicular

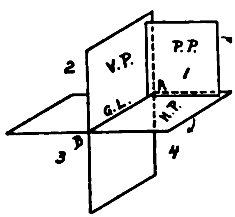


Fig. 1

to each other and intersect in a line called the ground line. While these two planes will in some cases be sufficient to properly and clearly represent the object, yet there are many times when a third plane, called a profile plane, is needed. This third plane is taken perpendicular to the other two planes.

Fig. 1 shows the arrangement of the three planes of projection. *VP* is the

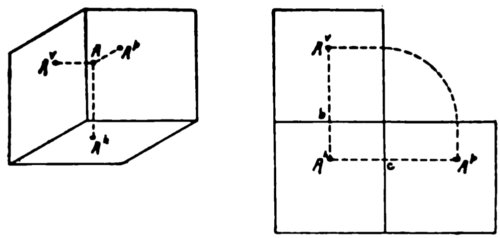


Fig. 2

When a third view of the object is needed it is shown on the profile plane *PP*, and this view of the object is called a side view or side elevation. It is important to notice that the different views of the object derive their names simply from the plane on which they are shown and not from the face of the object represented.

The *VP* and *HP* form four angles which have been numbered, in Fig. 1, as 1st, 2d, 3d and 4th angle, respectively. That is, if the object is assumed to rest on the horizontal plane, and in front of the vertical plane its projection is said to be a 1st angle projection; if the object is assumed to be beneath the horizontal plane and behind the vertical plane its projection is a 3d angle projection, etc. Usually in making the working drawings of any object, the object is considered to be in either the 1st or 3d angle.

Fig. 2 shows the point *A*, located in the 1st angle. This point is above *HP*, in front of *VP* and in front of *PP*. The projections of the point are A^h, A^v and A^p; the small exponents simply indicating upon which plane the projection is taken. The left-hand drawing in Fig. 2 shows the point in space and its relation to the three reference planes, while the right-

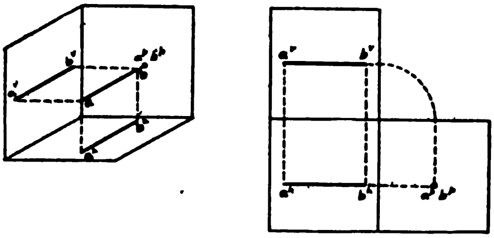


Fig. 3

Since both VP and PP are perpendicular to HP, it is evident that cA^p must equal bA^v.

Fig. 3 is the projection of a straight line which is parallel to both VP and HP. As in Fig. 2, and in most of the following figures, two drawings are given, the one being the projections of the line or lines upon the three reference planes as they might appear in space, and the other showing the projections as they appear when drawn on a flat surface. The line ab is located in the 1st angle, and its projections on the reference planes are found by first locating the projections of the extremities of the line and then joining, by means of straight lines, the points which have just been located. It should be noticed that the point a projects upon the reference planes giving the points a^v, a^h and a^p. The projection of the point b upon the reference planes gives the points b^v, b^h and b^p. Joining the points a^v and b^v, a^h and b^h gives the projection of the line ab upon VP and HP; but since the line ab is taken parallel to VP and HP, it is perpendicular to PP, and, therefore, its projection upon PP is a point.

Fig. 4 shows the projections of a line ab which makes an angle with each of the three reference planes and intersects VP and HP in the points a and b respectively. Projecting the point b upon VP and joining this point b^v with a by means of a straight line gives the projection of the line ab upon VP. Similarly by projecting the point a upon HP and joining the points a^h and b^h gives the projection of the line ab upon HP. To obtain the projection of ab upon PP, it is necessary to project both the points a and b upon this plane and then, as was done in each of the previous cases, join these projected points by a straight line. It should be noticed that all points are projected vertically upon the various planes.

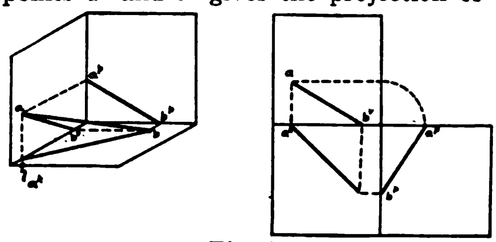


Fig. 4

Fig. 5A is the projection of a straight line which is parallel to both HP and PP. It will be noticed that the line

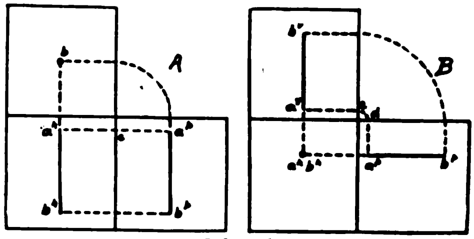


Fig. 5

will project upon VP as a point and the distance ca^p will be the actual height of the line above HP, while the distance ca^h will be the actual distance which the line is in front of PP.

Fig. 5B is the projection of a straight line drawn parallel to both VP and PP. Since the line is perpendicular to HP, its horizontal projection will be a point, while as in the previous case the distances da^p and ca^v will be the actual distance of the line in front of VP and PP.

Fig. 6 shows the projection of the plane A taken parallel to VP and perpendicular to HP and PP. In order to find the projections of a plane, it is necessary to

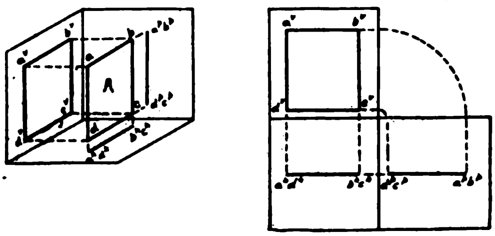


Fig. 6

find the boundary lines of the plane. It is true that a plane is of infinite extent, but since it is usual to work with but a portion of the plane, it is necessary to consider simply this limited area. The plane A is bounded by the lines ab, bc, cd and da. The projections of the points a, b, c and d give the projections of the four lines, and the projections of the four lines give the projections of the plane.

Since the plane is parallel to *VP*, its vertical projection will show the true size and shape of the plane. As the plane is perpendicular to both *HP* and *PP*, its horizontal and profile projections will be simply straight lines. This is, of course, true, since the points *b* and *c* project upon *HP* as a single point, and the points *a* and *d* project upon *HP* as a single point. Similarly the projections of the points *a* and *b* and *d* and *c*, upon *PP* are single points.

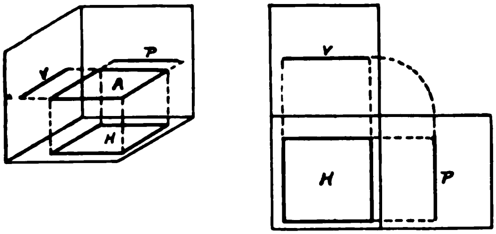


Fig. 7

Fig. 7 shows the projections of the plane *A* which is parallel to *HP* and perpendicular to the other two reference planes. As in the case of Fig. 6, the plane projects in its true size and shape upon the plane to which it is parallel, while its profile and vertical projections are but straight lines. For the sake of simplicity all lettering which can, has been omitted, and the projections of the plane *A* are designated simply by means of the letters *V*, *H* and *P*.

Fig. 8 shows the projections of the plane *A* which is inclined to *HP* at an

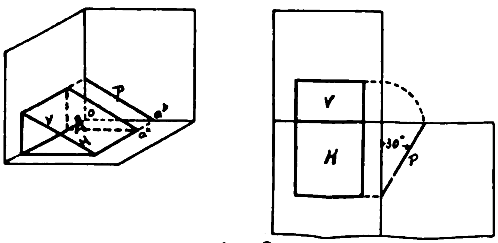


Fig. 8

angle of 30 degrees, and which is perpendicular to *PP*. It will be seen that the plane cuts *HP* and *VP* in straight lines, and these straight lines are called the horizontal and vertical traces of the

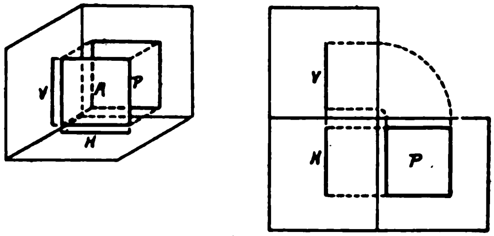


Fig. 9

show the true size and shape of the plane *A*, although the projection upon *PP* shows the true length of the plane, and the horizontal and vertical traces show the true width of the plane.

Fig. 9 shows the projections of a plane *A* which is parallel to *PP*. It will be an interesting and instructive exercise for the student to actually draw the projections to scale, and for this reason the location of the plane with respect to the various reference planes is given. The plane *A* is bounded by lines each of which is $\frac{15}{16}$ in. long and which make angles of 90 degrees with each other. The plane is located $\frac{3}{4}$ in. in front of *PP*, and its lower and left-hand boundary lines are each $\frac{1}{8}$ in. above and in front of *HP* and *VP* respectively. In drawing the projections of this plane or any other plane or figure, it is simply necessary to draw the projections as they would appear drawn upon a flat surface.

Fig. 10 is given to show the method of representing planes in descriptive geometry. This method does not require a profile plane, and the projections are not as self-evident as in the case of working drawings. The plane *Q* is inclined to both *VP* and *HP*, and intersects these planes in the lines *VQ* and *HQ* respectively. These lines are the vertical and horizontal traces of the plane and each trace makes an angle with the *GL*. The vertical trace is inclined at an angle of 60 degrees with the *GL*, and the horizontal trace makes an angle of 30 degrees with the *GL*. In descriptive geometry the

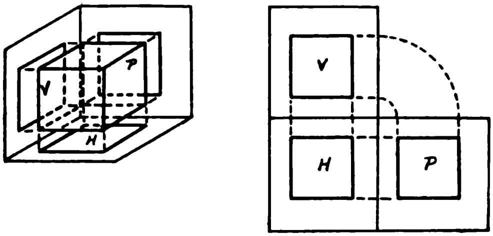


Fig. 11

planes are usually assumed to be of infinite area, but in mechanical drawing the planes are of limited area, since they form the faces of some actual object.

Fig. 11 shows the projections of a cube whose base is parallel to HP, and which has two faces parallel to VP, and two faces parallel to PP. Each of the faces of the cube is a square, and it should be noticed that each of these faces is a plane of limited area. To find the projections of the cube, it is simply necessary to find the projections of its faces, and the projections of its faces are found in the manner just described, when finding the projections of a plane of limited area. Because of the location of the cube with respect to the three reference planes, each of the projections of the cube will show the true size and shape of its faces. Since this is a treatise on Mechanical Drawing, the vertical projection of the figure should be spoken of as the front view, the horizontal projection as the plan and the profile projection as the side view.

Fig. 12A shows the projections of a parallelopiped. Each of the sides of this object is a rectangle and its ends are squares. The figure is so placed that its ends are parallel to PP, and two of its sides are parallel to HP, and two of them are parallel to VP. Because of the location of the object, it is evident that the projections of its sides and ends will show these sides and ends in their true size and shape.

the projections of a right cylinder. The axis of this cylinder is perpendicular to VP. The cylinder will project upon HP as a rectangle and similarly upon PP. The vertical projection or front view of the cylinder will show the true size and shape of the cylinder, and will be a circle.

Fig. 13 shows the projections of a pyramid whose base lies in HP and whose axis is perpendicular to HP. The base of this pyramid is a square, and each of its faces is a triangle. Since the base lies in HP, its horizontal projection will show

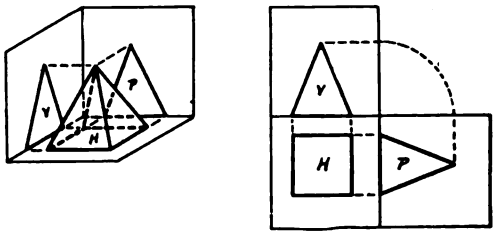


Fig. 13

its true size and shape, but as all of its faces are inclined to VP and PP, these faces will not appear in their true size and shape in either the VP projection or the PP projection.

To obtain the true size and shape of the faces of the pyramid, it is necessary to project the face upon a plane which is parallel to the face.

Such a plane is called an auxiliary plane. Auxiliary planes are very largely used in descriptive geometry, since by projecting the object upon such planes, it is possible to obtain a view of one of

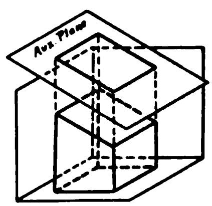


Fig. 14

its faces in which none of the lines are

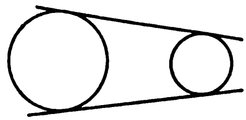


Fig. 15

object will project in their true size and shape, but the upper face being inclined to both *VP* and *HP* at an angle other than 90 degrees will not appear in its true size or shape in any of the ordinary views. However, by the use of a plane parallel to this face, called the auxiliary plane, it is possible to obtain a projection of the face which will show its true size and shape.

The authors of this department, believing that the only way to successfully learn mechanical drawing is by actually doing original work and by solving problems, have decided to include a certain number of study questions or problems at the end of each article. In some cases partial constructions of the problems will be given and the student allowed to

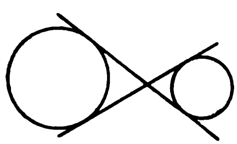


Fig. 16

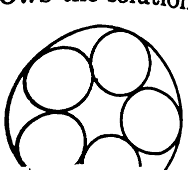
complete the solution. In other cases, however, the problem will be simply stated in words and the entire solution left to the student. It will be possible many times to solve the problems by "cut and try," or "short-cut" methods, but this should not be done, since each of the problems is intended to emphasize certain basic principles of drawing.

The problems which are given with this instalment are to be solved entirely by geometrical methods.

STUDY PROBLEMS

PROBLEM 3. *To draw a line tangent to two given circles exteriorly.*

Fig. 15 shows the solution of the problem, and the method of obtaining this solution is left to the student.



PROBLEM 4.—*To draw a transverse tangent to two given circles.*

Fig. 16 shows the solution of this problem.

PROBLEM 5.—*To inscribe within a given circle, five similar circles, the circles touching the given circle interiorly, and each other exteriorly.*

Fig. 17 shows the solution of this problem.

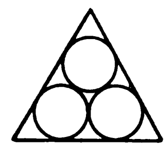


Fig. 18

PROBLEM 6.—*To inscribe within a given equilateral triangle, three similar circles, so that each of these circles will touch each of the other two, and also the sides of the triangle.*

Fig. 18 shows the solution of this problem.

The authors will be very glad to answer any questions which may occur to the readers, and to criticise any mechanical drawing work submitted, provided all communications are addressed to the Mechanical Drawing Department of the ELECTRICIAN AND MECHANIC, and return postage is enclosed.

The Calculation of Inductance

(Concluded from page 77)

the value of L one-half the length of the conductor in centimeters. This gives the value for very high frequency. If this is applied in the last example where $L = 799.55$ cms. and $l = 2 \times 3.1416 \times 15 = 94.248$ cms., we find that L^1, the high frequency inductance, is

$$L^1 = L - \frac{l}{2}$$

$$= 799.55 - \frac{94.248}{2}$$

$$= 752.43 \text{ cms.},$$

which checks very closely with the value obtained directly from formula (2).

The above formulas and tables will be found very helpful in the design of high-

HOW TO PRODUCE THE ULTRA-VIOLET RAYS, AND SOME EXPERIMENTS WITH THEM

G. G. BLAKE

Any amateur who possesses a coil capable of producing a 1-in. spark can, without much trouble or expense, fit up and work an ultra-violet ray apparatus.

Fig. 1 shows a diagram of the apparatus: *A*, switch; *B*, battery; *C*, coil; *D*, condenser (or Leyden jar); *E* and *E* are two small steel rods; *F*, box of wood or cardboard; *G*, hole cut in the side of box; *H*, coil of stout copper wire.

The battery, coil and switch need, I think, no further description, so I will pass on to describe the condenser *D*. There are various ways of making this. The figure shows it made of a square piece of window glass 14 in. square, coated on each side with tin-foil, to within about 1 in. of the edge. This is best stuck on with shellac paste, made by dissolving shellac in methylated spirits, and it is just as well, while using the shellac, to coat the edges of the glass with it, so as to prevent condensation of the moisture in the air from settling on the glass, as it is so likely to do.

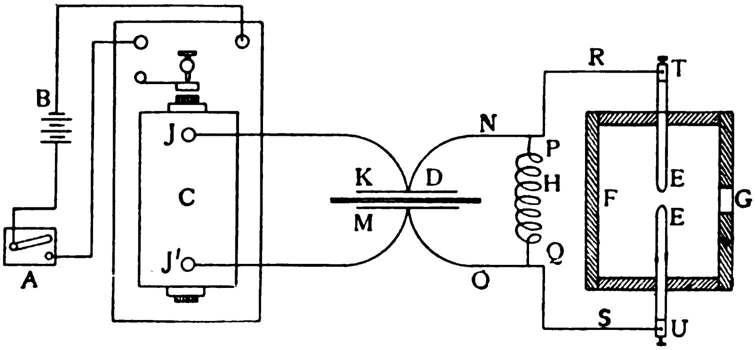


Fig. 1—Diagram of Apparatus

Another form of condenser which would serve the purpose almost equally well is the old-fashioned Leyden jar. A very serviceable one can be made out of a tumbler coated inside and out to within about 1 in. of its edge, with tin-foil, and the remaining exposed glass coated with shellac as in the last case.

Whichever form of condenser is used, one of the wires leading from the secondary of the coil *J* is connected to one coating of foil, *K* and wire *J*[1] from the other secondary terminal is connected to the other coating of the condenser *M*. *H* is a coil of stout copper wire about 4 in. in diameter and 10 in. long (see Fig. 2). It consists of only one single layer of wire. This should be quite uninsulated and of such a thickness that after it has been coiled into shape (round the body of a wine bottle, or anything cylindrical in shape) it will retain its shape when the bottle is afterwards removed.

The two ends of this coil, *P* and *Q*, are connected to the two coatings of the condenser by wires *N* and *O* respectively, and are also joined by wires *R* and *S* to the two steel rods *E* and *E*. These steel rods are made out of two pieces of stout steel wire about ⅛ in. in diameter, and the two ends *E* and *E* are nicely rounded with a file.

Box *F* can be made either of wood or cardboard. About 4 in. square is a convenient size (see Fig. 3). The steel rods *E* and *E* push in and out through holes in the sides of the box, so that the size of the spark gap between them can be regulated. On the other ends of the rods are soldered terminals *T* and *U*. *G* is a hole in the box 1½ in. in diameter, opposite the spark gap.

EXPERIMENT I

Procure a small piece of willemite (it is a natural silicate of zinc, any chem-

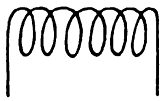


Fig. 2—Coil

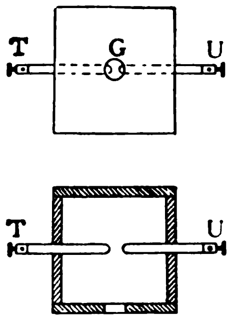


Fig. 3—Box

ist will probably be able to get this for you for a few cents) and place it in front of the opening of the box *G*, and in a perfectly dark room start the coil working. A bright blue spark will be seen between the rods *E E*, which makes a loud snapping noise, and the willemite will be seen to fluoresce a beautiful green color. If a small crumb of willemite be looked at under a microscope while it is fluorescing, it is especially beautiful. When a fairly large coil is used to work the apparatus, the willemite can be made to fluoresce, even when several yards separate it from the window *G*. If a piece of thin glass be now put in front of the opening *G*, the willemite will no longer fluoresce, but if a piece of quartz (say an old quartz lens from a pair of spectacles) be put in front of the opening, it will fluoresce quite as well as it did in the first case. This experiment proves the presence of the ultra-violet rays (which are invisible to the unaided eye), for if it had been the visible light rays which caused the willemite to fluoresce, the glass would not have stopped the fluorescence. And it also shows that whereas glass is opaque to the rays, quartz is quite transparent. Ice is also found to be transparent, and a small piece can be substituted for the quartz, with the same result.

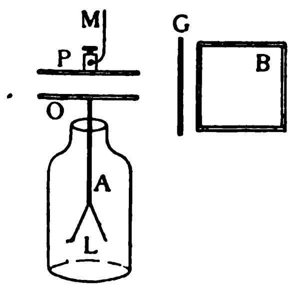


Fig. 4—Gold Leaf Electroscope

EXPERIMENT II

Several other substances also fluoresce under the action of the ultra-violet rays. Silicate of soda fluoresces blue, and it is especially noticeable with this chemical that the fluorescence continues for 5 or 6 seconds after the apparatus has stopped working. Should the reader happen to possess a platino-cyanide of barium X-ray screen, he will see that this will also fluoresce under the action of the ultra-violet rays.

EXPERIMENT III

Another proof of the existence of the ultra-violet rays produced from the spark between the steel rods is their power to discharge an electroscope. Fig. 4 shows a gold leaf electroscope charged either negatively or positively, so that the two gold leaves *L* are wide apart. *P* is a disc of brass the same size as the disc *O*,

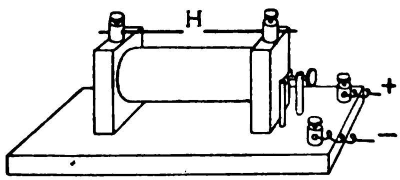


Fig. 5—Spark Coil and Gap

belonging to the electroscope, *P* is suspended by a wire *M* about 1½ in. above *O*, and is connected to the earth by wire *M*. A gas or water pipe makes a splendid earth connection. *B* is the ultra-violet ray box, and *G* is a piece of glass in front of the window between it and the electroscope. On the rays being generated nothing happens to the electroscope while the blue light coming through the glass passes between the plates *P* and *O*, but directly the glass is removed, and the ultra-violet rays are allowed to play on the air between the two plates, the air becomes a partial conductor, and all the electricity escapes from the electroscope to earth, with the result, of course, that the leaves close. A simple way of connecting up this experiment is to suspend plate *P* from a gasolier.

EXPERIMENT IV

This is another experiment which shows the action of the ultra-violet rays upon the air. A small coil is arranged as shown in Fig. 5, so as to have a spark

gap between the secondary terminals, which is so arranged that it is just too great to allow a spark to pass when the coil is worked. If now the ultra-violet rays are allowed to play on the air in the spark gap, a spark will pass, showing again that the air becomes more conductive when under the action of the rays.

There is a great similarity between the ultra-violet rays, the X-rays, and the Gamma rays which emanate from radium. Any of these rays will discharge a charged electroscope, affect a photographic plate or cause willemite, and other substances, to fluoresce; all are invisible to the unaided eye, and they are all of them ether vibrations. Violet is the highest rate of vibration which our eyes are capable of seeing, and above this next comes the ultra-violet. These rays have only about the same penetrative power as ordinary light. Higher than these in the spectrum we come to the X-rays and the Gamma rays, both of these having wonderful penetrative power, the latter in particular. With a small quantity of radium (6 milligrammes) I find that the rays will penetrate through nine pennies, placed one above the other, and will cause distinct fluorescence on a piece of willemite. —*The Model Engineer and Electrician.*

THE DIVINING ROD

The United States Geological Survey states in Water-Supply Paper 255, entitled "Underground Waters for Farm Use," just reissued, that no appliance, either mechanical or electric, has yet been devised that will detect water in places where plain common sense and close observation will not show its presence just as well. Numerous mechanical devices have been proposed for detecting the presence of underground water, ranging in complexity from the simple forked branch of witch hazel, peach, or other tree to more or less elaborate mechanical or electric contrivances. Many of the operators of these devices, especially those who use the home-cut forked branch, are entirely honest in the belief that the working of the rod is influenced by agencies—usually regarded as electric currents following underground streams of water—that are entirely independent of their own bodies, and many people have implicit faith in their own and others' ability to locate underground water in this way. In experiments with a rod made from a forked branch it seemed to turn downward at certain points independent of the operator's will, but more complete tests showed that this downturning resulted from slight and, until watched for, unconscious muscular action, the effects of which were communicated through the arms and wrists to the rod. No movement of the rod from causes outside of the body could be detected, and it soon became obvious that the view held by other men of science is correct—that the operation of the "divining rod" is generally due to unconscious movements of the body or of the muscles of the hand. The experiments made show that these movements occur most frequently at places where the operator's experience has led him to believe that water may be found.

The uselessness of the divining rod is indicated by the facts that it may be worked at will by the operator, that he fails to detect strong water currents in tunnels and other channels that afford no surface indications of water, and that his locations in limestone regions where water flows in well-defined channels are no more successful than those dependent on mere guess. In fact, its operators are successful only in regions in which ground water occurs in a definite sheet of porous material or in more or less clayey deposits, such as pebbly clay or till. In such regions few failures can occur, for wells can get water almost anywhere.

The only advantage of employing a "water witch," as the operator of the divining rod is sometimes called, is that crudely skilled services are thus occasionally obtained, for the men so employed, if endowed with any natural aptitude, become through their experience in locating wells shrewd, if sometimes unconscious observers of the occurrence and movements of ground water.

A copy of the report may be obtained free on application to the Director of the Geological Survey, Washington, D.C.

NOTES ON DRILLS, REAMERS AND BROACHES

GEORGE GENTRY

One of the most important factors in the use of the ordinary twist drill is to remember that it is not a reamer, nor was it ever intended to be used to enlarge a hole smaller than itself, unless there be a reasonable difference in their sizes. All the work done by a drill of any kind should be carried by the bottom cutting edges or lips equally, the clearance and rake of which are in accordance with the conditions in such as a lathe or planer tool. This is shown on Figs. 1 and 2, and it should be noted that the extremes of these edges *aa*, Fig. 2, must not be allowed to become worn away, otherwise the edges of the flutes will take some of the work, and the drill, sooner or later, seize and break. If it does not break, the flute edges, not being adapted for cutting, as in a reamer, will rapidly wear, thus throwing the drill out of caliber, and making it useless so far as the worn portion is concerned. The lips should always be of the same length and to the angle given. It may not be generally known that the peripheral portion of a twist or straight-fluted drill—indicated by *bb*, Fig. 1—is, even in the smallest sizes, backed off, as shown on the point elevation, Fig. 2, leaving very little surface to resist wear, as mentioned above.

FIG. 2.

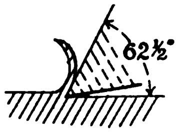


FIG. 3.

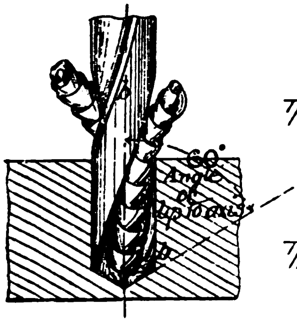


FIG. 1.

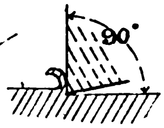


FIG. 4.

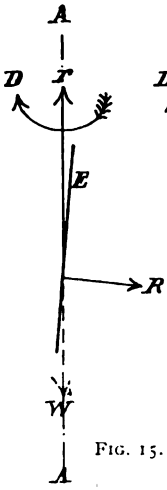


FIG. 15.

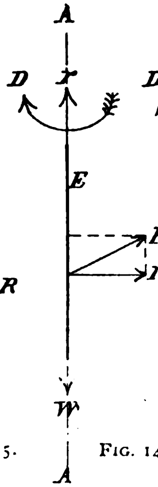


FIG. 14.

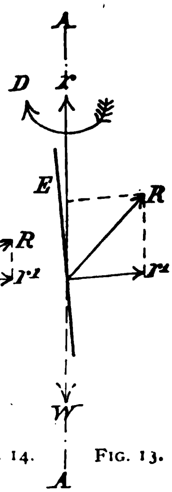


FIG. 13.

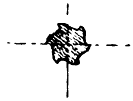


FIG. 8.

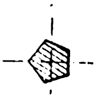


FIG. 11.

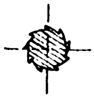


FIG. 9.

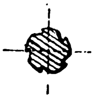


FIG. 10.

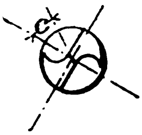


FIG. 5.

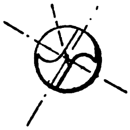


FIG. 7.

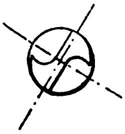


FIG. 6.

FIG. 7.

FIG. 12.

Suppose it is wanted to enlarge a hole ⅛ in. in diameter to ¼ in. This can be done by means of a ¼-in. drill with safety, without putting any undue strain on the flute edges; but the resultant ¼-in. hole is not so likely to be cylindrically true, on account of the point not coming into play and steadying the drill, neither can the exact position of the hole be maintained, as in the case where reamers are used.

Fig. 3 is an enlarged section of a twist drill cutting edge, showing how the rake is adapted for cutting wrought and cast iron, steel, copper, aluminium, or other tough and stringy metals. Fig. 4 is the corresponding section of a straight-fluted drill, showing the absence of rake. It is this feature which makes the latter drills so useful for brass work, and especially for thin plate work in any metal, as the drill is not able to jump forward, which is usual with a twist drill just before it clears its way through the metal. This trouble arises from the fact that the direction of the twist of the flutes is right-handed (*i.e.*, the same as the direction of a right-handed screw thread, which must be so, or the cutting edges would have a negative rake and would scrape rather than cut), and the tendency of the drill actuated by the feed is to force an 8-shaped hole and to follow the same, screw fashion. It will be shown later on why the flutes of a twist reamer have to be left-handed to avoid much the same tendency. The outline of the flute surface and periphery of the drill, as shown on the point elevation in Fig. 2, will clearly demonstrate the uselessness of a fluted drill for cutting with the flute edges, and compared with Fig. 8, which is a section of a fluted reamer, this will be still more clearly seen.

Reverting to Fig. 3, it will be noted that the angle of rake is 62½ degrees to the plane of the cut. This generally applies to twist drills only, when they have not been worn away much, as it is usual to increase the angle of the twist from that given above at the point to about an angle of 72½ degrees to the same plane at the shank end; the object being to increase the cross-sectional area of the drill near the shank for purposes of rigidity, and to resist torsion, and this without diminishing the cross-sectional area of the flutes. It is obvious that the sharper the angle of the flute in relation to the axis the less metal is removed from the body of the drill to excavate it, and made, and one method of obtaining the advantages of the increase in same is gradually to alter the angle of the milling cutter in relation to the flute so as to cut a wider groove at the top end, and at the same time a shallower one, thus obtaining a thicker web in center without any decrease in the cross-sectional area of the groove or any increase in the total cross-sectional area of the drill itself; the center of the web being regarded as the weak point to be protected against torsion.

In reference to grinding the cutting edges, it must be borne in mind that just sufficient backing off of the point facets is necessary only, and that too much clearance causes the drill to cut rankly and almost as badly, from a practical point of view, as if no clearance was given at all. The best indication for grinding is to observe the angle of the center cutting edge in relation to the lips of the drill. Fig. 5 gives this correctly at *c*, while Fig. 6 shows the angle formed (approximately) by too little or no clearance, and Fig. 7 the reverse, or too much clearance; in short, the drill is here too sharp to maintain an even cut with sufficient feed to make it cut at all. (Note that the thickness between the lips is shown greater than necessary for good cutting to accentuate this angle in these views.)

Readers may have found difficulty in grinding very small twist drills, such as from Nos. 65 to 80. It is not necessary to round off the clearance in such small drills as these, a flat backed-off clearance to the lips being sufficient. The following method with a little practice will answer the purpose. First accustom yourself to holding a wire, with both hands on a rest, to the periphery of a revolving stone, which must run at high speed away from you, so that the resultant flat surface ground is approximately at an angle of 60 degrees to the axis of the wire, with a slight inclination of the end of the wire nearest you to the right to give clearance.

revolve the drill in your fingers, and treat the opposite side the same, giving the same period and compression to the touch. With a little practice, this is so efficient that one cannot detect with a powerful glass the slightest difference in the length of the lips in quite the smallest drills.

When using small drills, do not try the watchmaker's method of using a drill arbor and bow. This requires a great deal of practice and an extra special sense of touch. Mount the drill in the lathe chuck (preferably a three-jaw scroll chuck, which must, of course, run true). If the drill is too fine for the jaws to grip, take a strip of blotting-paper or newspaper about 3/8 in. wide by 1 in. long, moisten slightly, and roll it on the drill shank between the thumb and first finger until the mass of paper is quite tight. This will be found an effective packing, and in the writer's experience, a drill so mounted will run true nineteen times out of twenty. Feed with the poppet head with back center removed; and if the work is small, back it up with a flat piece of hard wood. Do not support the work in your hand, but pack under so that the drill takes no weight. Run the lathe at the highest possible speed, avoid vibration, and use oil as lubricant for all metals. Only practice and familiarity with your lathe will enable you to feel the proper feed necessary for fine drilling. In any case do not try to drill holes below .04 in. with a hand brace. The writer thinks—from bitter experience—that it is well-nigh impossible. Better results can be obtained with an Archimedean drill brace using the usual spade-pointed drills, but great care is necessary with all hand tools. The above hints are given assuming the reader does not possess the luxury of a high-speed sensitive drilling machine, which is doubtless the best tool for actuating fine fluted drills.

REAMERS AND BROACHES

Reamers and broaches are tools for enlarging and truing to a gauge diameter parallel reamers for about one-sixth of their length from the point upward. Fig. 8 is a section of the flutes looking on the point of the latest and best form of six-fluted reamer, showing the shape of flute and backing off of cutting edges. This latter is usually done on a special grinder and constitutes the final process of gauging the tool to size. Fig. 9 is also a good form of multi-fluted reamer, which necessitates the turning of the original blank to gauge and very careful fluting, as it will be seen at once that any extra depth of flute will rob the tool of its diameter, and any shallowness obviates its cutting capacity. Fig. 10 shows the old original form with five flutes, which retains its gauge diameter and wears well; but is not so efficient a cutter as the foregoing, on account of the lack of backing off, although for strength it is far and away superior. Fig. 11 is the usual section for broaches, which are always made with five cutting edges. In addition to these, square section taper reamers (or more properly broaches) are largely used for cutting taper-pin holes in machinery and for enlarging roughly holes in metal plates for taking wood screws. These usually have tapered square shanks and are adapted to fit carpenters' bit braces.

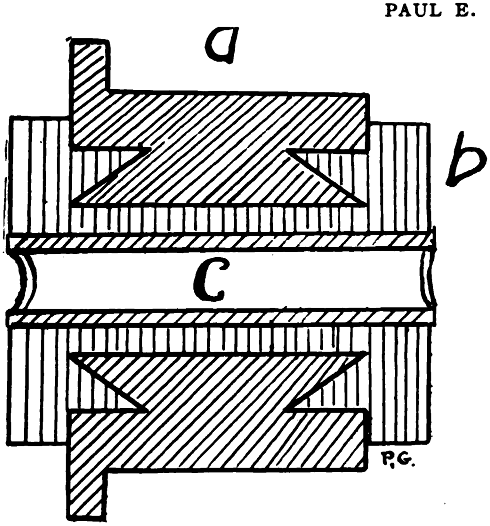
The best design of reamer for general work is that shown in Fig. 12 with left-hand twist flutes, although this is not the general kind sold in tool shops. The straight-fluted variety is more generally found in stock. This is probably due to the fact that straight flutes are easier to produce and do not require the extra feed necessary in milling machines for their production. A glance at Figs. 13 and 14 respectively will demonstrate the superiority of the left-hand twist flute as against the straight. It will be seen that, for any one cutting edge, there are two resistances r and $r1$, acting respectively along the axis AW of the tool and at an angle of about 90 degrees to the edge. The first is that against the weight

proximated as equal to $r1$, and their resultant R, in the direction shown, is one-sixth of the total resistance, forcing the reamer out of the hole and preventing its seizing. In Fig. 14 the resistance r is considerably less, as E is much nearer in direction to that of rotation D, and in the same as that of W, hence R, the resultant, is not so effective in freeing the reamer, and as E is in the same direction as W, unless great care is taken the tool will chatter and form an approximate hexagonal hole, especially if used in thin plate work. Fig. 15 shows that with a right-hand flute the inclination E being with the direction of rotation D, r is practically eliminated and $r1$ becomes R. This form would undoubtedly seize and very soon break, as the total resultant tends to draw the tool deeper into the hole.

Broaches are made very slightly taper their whole length, and are gauged at the upper shoulder or maximum diameter to Stubb's steel wire gauge. They are very handy tools, as they will cut in either direction, and will rapidly enlarge holes in plates using a reciprocating rotary motion with a fairly long stroke. If habitually used one way and they become dull on the edge, a reversal of motion will often be an improvement, and will have the advantage of setting the edge for the first direction. They are used largely in clockwork, and their taper is so slight that in plate work it can be disregarded. These tools are generally actuated by a handle provided with a chuck adapted to take several consecutive sizes.—*The Model Engineer and Electrician.*

AN UNIQUE COMMUTATOR

PAUL E. GOLDMANN



An invention that will in all probability revolutionize the manufacture of small commutators and cause the passing of the present taper ring method of con-

placing the bars (with mica between) in a circle and putting a circular clamp around them is followed in this invention, and if necessary this combination is put into a lathe and the tapered recesses "trued up."

The partly finished commutator is then placed in a mould and a bushing of the requisite size is placed in the exact center. The space between the exterior of the bushing and the interior of the commutator, including the tapered recesses, is then filled in with this special compound. Heat and pressure are applied, and these melt and compress the powder into a solid mass.

This mass upon cooling hardens and forms an insulating binder, serving the same purpose as the steel and mica rings used in the old method of construction. This substance when hard can be cut and polished the same as rubber or fiber.

The parallel lines designated by B

SOFT-SOLDERING, TINNING AND SWEATING

OWEN LINLEY

What is generally termed soft-soldering, in order to distinguish it from hard-soldering, or brazing, is one of the most useful processes for the amateur; but he hardly ever performs it well, his joints usually being clumsy and leaky. It is, in reality, one of the simplest processes, and requires hardly any skill, if once clearly understood and a correct start made.

The first thing to be considered is the outfit, and in this the most important thing is the copper-bit, or soldering-iron, as it is sometimes called, and here we come to the first mistake usually made by the amateur, who generally has a bit far too small to be of any practical use. It would puzzle some professionals to do good work with the tiny bits used by some amateurs. What may be termed the ordinary standard bits are shown in Figs. 1 and 2, where it will be seen that the straight bit has two different kinds of ends, and the flat end is best if it is not required to work into corners, as it conveys more heat to the work. The hatchet-bit is more convenient to use on long seams, and an adjustable bit can be obtained which combines the two. Within certain bounds, the larger the bit the better and sounder will be the work produced by it, provided it is properly used. A bit, the body of which is from 1 in. to 1¼ in. in diameter, will give good results without being unduly heavy.

Having settled on a bit, the next thing to consider is the means of heating it, and the best, of course, is one of the stoves made for this purpose. Next to this, an ordinary gas-stove can be used. If no gas is available, a forge or ordinary domestic fire can be used.

We now come to one of the most important matters in soft-soldering, and that is the tinning or coating the end of the bit with solder, for unless this is properly done, it is almost impossible to produce good work. It is always best

prevents its getting burned or roughened, which stops the solder running properly. Another thing is that if a good supply of heat is in the body to start with, the end remains hot so much longer. In order to tin the bit, some flux is necessary to remove the oxide produced by heat, and there are several of these which will be described later; but as far as tinning the bit goes, the old-fashioned "killed spirit," although objectionable in some ways, is perhaps the most efficient in the hands of a beginner. It is prepared thus: Get some spirits of salts, which can be

Fig 1

Fig 2

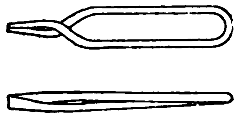


Fig 3

Fig 4

obtained at any chemist's or oil-shop, put it in a jar, and drop a few zinc cuttings in it. This should be done in the open air, as it gives off poisonous fumes. The spirit, or, to speak more correctly, acid, will dissolve the zinc, and then more should be added, until it remains undissolved at the bottom of the spirit, and bubbles of gas are no longer given off. The objection to this preparation is that it rusts iron or steel, and therefore cannot be used under certain circumstances, as will be explained later, and it gives off a vapor that attacks bright work or tools in a workshop; so it is best, when it is killed, to pour it off into a wide-mouthed jar or bottle, which can be closed with a bung when not in use.

There are several varieties of soft-solder; but that mostly used for sheet-metal work is called tinman's solder, and

small block of sal ammoniac, about 2 x 2 x 1 in. high, and with the upper surface formed slightly hollow, while others use a piece of ordinary brick, which is useful if Fluxite is used to tin the bit. This preparation is excellent, and very handy to use, and does not cause rust; but is not so powerful as the spirit. It is a good thing to have a piece of canvas or sacking handy, with which to rub the body of the bit clean, and this is more especially the case if it is heated in a fire, and is not very clean, as any soot or particles of coal adhering to it give off smoke, which causes the end to oxidize. Some workmen are very particular about this, and there is no doubt it is worth attending to, and also if a fire is used, it should be kept as free from smoke and flame as possible. The end of the bit should now be filed up smooth to whichever shape is required, and the extreme corners should be rounded off with the file, as this helps to keep it smooth.

The bit is now heated as already described; the whole body, not merely the end, being heated; and if a fire is used, it is best to let the end pass through it into a cooler part. The bit should be hot, so that the solder melts as soon as it is applied to it; but as it will not do this until the bit has been tinned, a certain amount of guesswork will have to be used at first; but it should never be allowed to get red-hot. When the bit is considered to be hot enough, it should be withdrawn from the fire, the end rubbed bright with the file, then dipped in the spirit, and the solder applied to it. These operations should be performed as quickly as possible, and if all is right the solder should unite to the end of the bit, and this can be assisted by rubbing it on the piece of sal ammoniac or brick. The operation may have to be repeated two or three times, but should be kept up until the whole of the end of the bit is covered with solder.

The bit being properly tinned, we will now consider applying it to the work. It must be remembered that the flux should always be put on the work before the bit is applied to it and has made it hot. By this means the oxide is prevented from forming at the beginning of the job. In new work where the surface of the metal is clean, care should be taken to be sparing with the flux, and only apply it where it is wanted, or the melted solder will follow it, and make a wide, unsightly seam. One advantage of Fluxite is that, being a paste, it is not inclined to run about on the surface of the work as spirit does.

The best thing with which to apply the flux is a piece of cane with the end cut to a point, and pounded with a hammer so as to form a kind of small brush. In running joints or seams, the bit should be moved slowly along the work, so that the heat can soak in, and should never be rubbed backwards and forwards, as this makes a rough-looking joint, in fact, the appearance of the joint is a great indication of its soundness, as its surface should be smooth and shining; but if, on the other hand, the solder is rough, and seems inclined to stand up in little spikes, it is a sign that the bit was not hot enough, or it was applied too hastily to the seam.

Of course, there are many ways of using a bit, and much depends on the kind of work, and whether its appearance matters or not. In some cases it is best to use a pyramid-shaped bit, and draw one of the corners (not the point) along the seam; but in working inside a piece of work, this cannot always be done, and a chisel-ended bit has to be used. As the bit is moved along the seam, solder can be fed to it; but this is apt to make a clumsy joint in the hands of a beginner, and in small work, where neatness is wanted, it is sometimes best to pick up some solder with the bit, and apply it to the work. Some have a globule of solder in the hollow in the block of sal ammoniac, and take up what is wanted from this; but it sometimes happens that the whole globule will unite to the bit, and perhaps a better way is as follows: Put a little flux on a piece of clean tin, and apply some solder to the bit, and let it form a blot on the tin, and from the edge of this blot can be picked up exactly the amount of solder required, as you would take up some oil-paint from a palette.

The bit has to be retinned from time to time, so as to keep it in good condition, and the edges slightly rounded, as the frequent dipping in the spirit, instead of rounding these as might be expected, has the opposite effect, and makes them stand up sharp and ragged. If trouble is experienced by the solder's running where it is not wanted, it can be stopped by painting the work in those parts with

a mixture of size and lampblack; but this is seldom necessary if care is taken with the flux.

It is difficult to get solder to flow over a gap (even if it is very small), and in joining two sheets of metal with a plain lap-joint (not folded) the heat of the bit causes the edge of the upper sheet to buckle slightly, so that it is difficult to keep it down close on the lower one. This may be prevented thus: Set the edge of the upper sheet slightly, as in Fig. 4, where it is shown somewhat exaggerated, and this should be done with a mallet—not a hammer, as this would stretch the edge of the metal.

In repairing old tin work, all rust and scale should be removed by a scraper, which is best made out of a three-square file that has had the cuts ground off it. For this class of work spirits of salts are best; but the work should be well washed after it is finished, or rusting will set in.

What is known as sweating is joining two pieces of metal by external heat, the surfaces of which have been tinned or coated with solder. A good example of this is the sweating of a union on to a brass or copper pipe. In this class of work, the first thing to do, if a sound joint is wanted, is to make certain that the pipe does not fit too tightly in the union, so as not to leave room for the solder, and this applies to any work of this kind, such as sweating a collar on a spindle, etc. The inside of the union must now be tinned thus: Make a spatula out of a piece of brass wire, flattened at the end and tinned with solder; put some flux inside the hole in the union, and hold it by a wire clip over a Bunsen burner or gas-stove until it is hot, and then put a piece of solder inside, and when it melts, spread it about with the spatula. The end of the pipe can be tinned the same way, and, while hot, wiped round with a piece of rag to spread the solder. Some flux should be put on both, and they should be heated together, and one inserted in the other, and held in the flame until they are united. As you cannot see inside a sweated joint, it is somewhat difficult for a beginner to tell if it is sound or not,

If all is right, the end of the solder should melt at once, and appear to be sucked into the joint.

In some cases pieces of work can be pinned or riveted together after the surfaces have been tinned, or spring-clips can be used to hold the work together, and these are easily made, being about $\frac{1}{8}$ in. wire, flattened at the ends and bent as shown in Fig. 3, and they are very useful for holding small pieces of work.

Where clips or rivets cannot be used, it is sometimes convenient to hold pieces of work together with what is known as binding wire, which can be obtained at most ironmongers. It is a very soft annealed iron wire, and being black from the softening, if the flux is kept away from it, solder will not adhere to it.

A blowpipe can be used for tinning and sweating work, but is much inferior to the flame of the Bunsen burner, and the results are not as certain. In the case of work that is too large to be heated by a burner of this size, an ordinary gas-ring is useful. The best flame for this class of work is an upright Bunsen burner, and these can be bought or easily extemporized thus: Take a piece of brass tube about 5 in. long, and $\frac{5}{8}$ in. in diameter. About $\frac{1}{2}$ in. from one end, file two notches, and then pinch that end together, so that it just fits on an ordinary gas-burner.

Turn the gas on, and light it from the top, and if all is right, the flame should deposit no smoke on a piece of bright metal held over it.

If it does so, it is not getting enough air, and the notches should be enlarged until the flame is smokeless. The gas must not light inside the tube, and if it persists in doing this, it shows it is getting too much air. A piece of thin metal bent so as to clip round the tube can be used to regulate the amount of air that comes in by the notches. These burners are very useful for a variety of purposes, such as tempering, etc., and can also be used for heating the soldering bit if a stand is made to support it.

In some cases, especially in sweating

AN INVESTIGATION OF EXPLOSION-PROOF MOTORS

The term "explosion-proof," as applied by the Bureau of Mines to an electric motor, refers to a motor inclosed by a casing so constructed that an explosion of a mixture of mine gas (methane) and air within the casing will not ignite a mixture of the same gas surrounding the motor. There are two classes of motors so constructed: First, a totally inclosed class built strong enough to withstand high internal pressures and so designed that the efficiency of all inclosing covers can be satisfactorily maintained; second, a class provided with relief openings or valves designed to relieve the pressure of an explosion within the motor casing and to cool any products of combustion discharged through the valves.

A satisfactory motor of the first class is much more expensive to build than an equally safe motor of the second class. For this reason, attempts to make motors explosion-proof have been confined chiefly to motors of the second class.

The function of explosion-proof devices for electric motors is to reduce below the ignition point of gas (methane) the temperature of any flames that may be discharged from the motor casing. The temperature reduction is effected by removing the requisite amount of heat from the flames during their passage through the devices. Various plans have been proposed and developed for thus removing heat from the products of explosion. The principle of the Davy safety lamp has been the basis of most of the protective devices designed for explosion-proof motors. The application of this principle consists in causing the discharged gases to pass over or through metallic plates or screens which by conduction remove the heat from the gases. In some types of devices the cooling effect of expansion is also utilized.

For the sake of simplicity, the means used to cool incandescent gases will be termed, "Protective Devices," whether they consist of valves, layers of gauze, or metal plates.

The investigation described in bulletin No. 46, was undertaken by the Bureau of Mines as one of several investigations having for their purpose the ascertaining of methods for lessening the risks attending the use of electricity in mining.

The Bureau began this investigation by sending a circular letter to manufacturers of electric motors for mine service, stating that the Bureau proposed to make tests of electric motors designed for operation in the presence of gas (methane) in order to determine their suitability for such service. This letter was sent to all manufacturers whom the Bureau believed would be interested in the proposed tests. Five motors were submitted for test, no two being protected in exactly the same manner.

In this report the results of tests are related to the various types of protection employed, which are described in detail.

According to the definition of an explosion-proof motor, such a machine can presumably be safely operated in an atmosphere containing gas (methane) under conditions most conducive to explosion, provided that the protective devices with which the motor is equipped are in good condition and in their proper places. In conducting the investigation, an effort was made to produce conditions that would probably introduce the greatest elements of danger. In the earlier tests especially, and to some extent in subsequent tests, it was not evident just what the most dangerous conditions would be.

Copies of this Bulletin may be obtained by addressing the Director of the Bureau of Mines, Washington, D.C.

Bronzing Brass

Mix 1 oz. of flour of sulphur and ¼ lb. of pearl ash, and put in an iron ladle over a good fire. Keep stirring until it is a well mixed reddish-brown mass, and then turn out on a flat stone. When cold, pour on it 3 pts. of boiling soft water, and, after standing for some time, pour off the clear liquid and keep it for use. The article to be bronzed should be carefully cleaned with dilute nitric acid and then hung in the liquid until dark enough. To make the coating more permanent, the article should, after having been dipped once, be washed and dried, and again placed in the bronzing solution.

A D'ARSONVAL GALVANOMETER

PERCY W. BAKER

The following is a description of a d'Arsonval galvanometer, with scale and lamp, which I have just made, and with which I have obtained some very good results. To construct a similar instrument, first obtain a piece of wood 2 ft. x 6 in. to form the base for the galvanometer and lamp, which are fixed at the two ends. Next get a piece of brass rod bent and fixed to the end of the base, as shown in Fig. 2. At the end of this a nut is soldered to hold the adjusting screw for the coil, Fig. 2, which must come exactly over the center of the magnet to allow the coil to swing within the magnet poles without touching either side. The coil frame is made of beech wood, Fig. 6, and is wound with eight layers of No. 42 s.c.c. wire, well soaked in paraffin wax, and the two ends are fastened to two brass pins, one of which is fixed at each end of the coil. The top pin is then fixed to the adjusting screw at the end of the brass rod by a piece of silver wire (the finest that can be obtained) to allow the coil to swing freely within the magnet poles. The bottom pin is then fixed to a pin in the base in the same manner, except that the silver wire used for connecting should be twisted into a spiral, so as to give the coil easier movement, Fig. 4. Near the top of the coil the small mirror is placed, but care must be taken to leave room for the clamp, Fig. 5, which holds the coil in place when it is not in use. At the other end of the base the lamp is attached in the following manner: First obtain a piece of brass rod and fix it to the base Fig. 1, for the lamp to swing on. This consists of a round tin with a hole

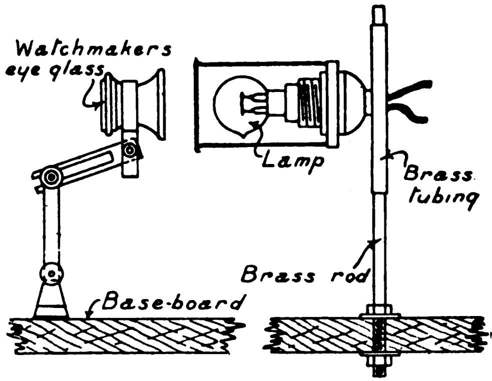
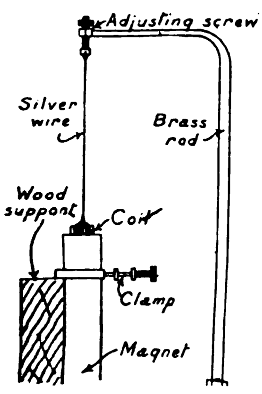


Fig. 1

cut in the end to fix it to the lamp-holder, which is one such as is used for ordinary electric lamps. To the connecting-posts inside the holder, connect two pieces of copper wire, which are then connected to a 4-volt 4 c.p. Osmi lamp, Fig. 1. A small hole about 3/8 in. in diameter is now cut in the lid of the tin to allow the light to shine on the mirror. Between the lamp and the coil a watch-maker's eyeglass is fixed, Fig. 1, which can be



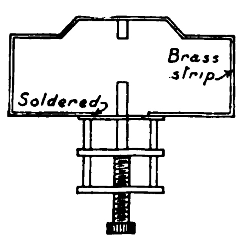
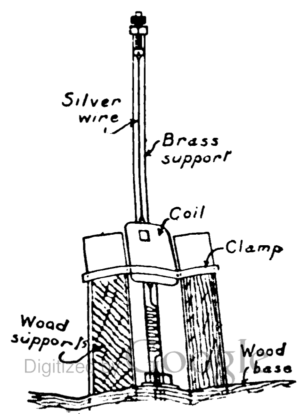


Fig. 5.



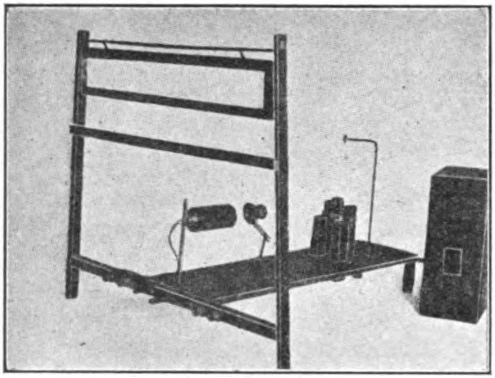
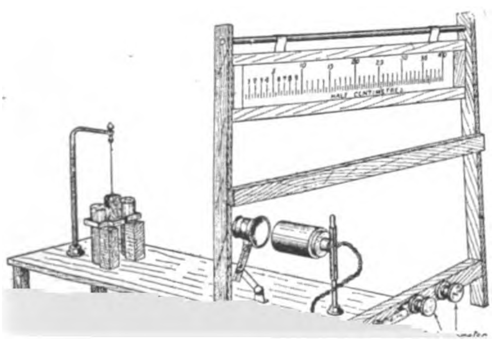


Fig. 3

adjusted so as to focus the lamp on the mirror and so adjust the reflection on the scale.

The scale, Fig. 7, is made of transparent paper marked off in half-centimetres, and is suspended to a brass rod which is fixed to the two uprights which hold the base in position, Fig. 7. Along the bottom bar to which the base is fastened, there are the connecting terminals for the battery and galvanometer, each of which has a switch; the one for the galvanometer being used in the place of a tapping key. The mirror on the galvanometer will have to be attached after the scale and lamp are in position, because it will require tilting at an angle, so as to reflect the image of the lamp on the scale. This can be fixed in position with thick shellac varnish, and then allowed to dry.

This instrument, if made as described, a 1,000,000th part of a volt should give



one millimetre deflection on the scale. To obtain a 1,000,000th part of a volt, get a piece of copper and constantan wire, and solder two ends together. This forms a thermo-couple, the voltage of which is 0.0004 of a volt for a rise in temperature of 1 degree C. Next get some water, the temperature of which is 1 degree C. above the temperature of the room in which the thermo-couple is located. Connect the remaining end of each wire to a terminal, and allow the spot of light to come to rest. Then plunge the soldered ends of the wires into the water, and a deflection of about 36 millimetres should be obtained.

It should be mentioned that the photograph of the instrument was taken when the coil was clamped.—*Model Engineer and Electrician.*

Uranium

There is considerable popular interest in uranium in the United States on account of its connection with radium, the properties of which appear so marvelous when compared with those of more familiar materials. But very little uranium is mined in this country except as it is incidentally taken out in mining carnotite for vanadium, according to the United States Geological Survey. In 1911 the uranium mined amounted to about 21.2 tons. A few hundred pounds of pitchblende was mined from the German mine, at Central City, Col., but this material was not sold, as it was said to have been used in experimental work. The extraction of radium has been attempted in the United States by several persons and firms. Some of these have given up their efforts, but others are still at work, with what success is unknown.

The uses of uranium and its compounds are comparatively few. It is employed principally for making yellow glass, for yellow glazes on pottery, and in a less degree as a chemical reagent. Yellow glass made with uranium oxide is known as "opalescent." Direct light shining through it gives a yellow color and indirect light a greenish yellow. Some of the firms which have attempted to use

TESTING AND ADJUSTING THE BACK CENTERS OF A LATHE

H. R. BECKETT

Having occasion to do some accurate drilling in the lathe, the following method of testing the back centers occurred to me. It is, however, only applicable to lathes having hollow mandrels, and can only be done during the evening, or when it is dark—time generally convenient to the amateur. It need be done only once, and will be time well spent for all who contemplate doing serious work with this kind of tool.

The front centers must first be correctly adjusted, using sharp pointed, truly turned centers—preferably those not hardened, as this process, unless done very carefully, is apt to throw them out of true. Clean out the mandrel bore by poking through small pieces of waste or rag with a stick. Fix up a powerful lamp, incandescent gas burner or, best of all, an acetylene lamp at the back end of the lathe mandrel, so as to project a strong beam of light through the mandrel bore. A mirror at the back of the source of light will be a further improvement. Now take a piece of thin white card about 6 in. square, and describe on it a number of concentric circles about ¼ in. distance apart, using black drawing ink and making the lines fairly thick; pin this card to a rectangular block of wood, so that the center-picked hole in the card is on a level with the lathe center, and with the circular lines facing the beam of light. Let the room be made as dark as possible, shutting out by screens all the stray light from the lamp used. Move the poppet head to the far extremity of the lathe bed and place the card, taking care that it is square on the lathe bed and the centrally pricked hole is exactly on the point of back center. A set-square placed across the lathe will keep the block of wood which carries the card square and in its correct position.

The disc of light projected must be adjusted until it exactly fits the circles upon the card. It is well first to turn the lathe ... the headstock must be adjusted by loosening the large bolts and using the setscrews usually provided for that purpose; if not, it must be tapped with hammer until the correct position is obtained, and then made fast. Do not overlook the fact that any alteration in the back setscrew will also necessitate adjustment of the front setscrew, for upon moving the back setscrew you put the headstock center in a fresh position. A little patience is required, but one will be well repaid by the future accuracy of the work turned out. If the edge of the projected circle of light is not sufficiently defined, the back headstocks can be brought up closer to the light. Of course, the greater the distance that the observation can be made the greater will be the divergence

Card for Use in Testing the Back Center of Lathe

shown if the centers are out, and in consequence the more sensitive the test.

Another way that I have tried—precise enough for most work, but not so fine a test as the above, though applicable to any lathe—is this: True up the front centers as before. Take a piece of hardwood having one side planed smooth, and about 2 or 3 in. thick; attach to the bottom of this another longer piece of wood which has been made a sliding fit in the lathe bed. Put a sharp twist drill—the bigger the better—and carefully drill a clean hole through the wood, placing the prepared smooth side of wood for the exit of the drill and feeding up the wood by means of a plate on the poppet head, another small piece of wood being placed between the wood being

TREATMENT AND FINISHING OF FLOORS

A practical painter who has been in the habit of finishing floors in various ways, such as painting or graining when too much worn to finish in the natural, raises the question as to the best way to finish floors and how to wax and polish them. He also asks how painters in the larger cities treat hardwood floors. In replying to these questions of its correspondent, *The Painters' Magazine* presents in a recent issue the following interesting comments:

For ordinary floors, such as in kitchens or laundries, warehouses, etc., the floor oil treatment is most practised. This consists in applying to the new floor a non-drying mineral oil, which is prepared for the purpose by heating in a hot-water bath 1 gal. of light paraffin oil to near the boiling point, and in the meantime melt in a ladle ½ lb. of paraffin wax, adding same to the hot oil, while continually stirring. Stir occasionally, while the mixture is cooling, to keep the wax from going back into lumps. The oil is applied to the floors with a brush, allowed to soak into the wood, and when well set the floor is wiped with a woolen rag wrapped around a floor brush to remove the excess of oil, so as not to soil dresses. The operation should be repeated until the wood is so saturated all over that no flat spots are visible, but a finished surface apparent all over the floor. This finish applies only to soft and hard pine as well as spruce. It is what has been called "dustless" floor finishing, and when the wood is once well saturated it does not need oiling again for from four to six months, and is far cheaper than waxing.

Oak and hard maple floors also are often simply oiled, but for these woods the floor oil described above is not the proper material. Take ⅙ gal. of kettle-

Yellow or hard pine floors may, without any previous treatment, be waxed, and the best method is to use one of the reputable floor waxes now on the market, applying same to the wood as directed, and then polishing by the use of the weighted floor brush. When the first coat, which acts as the filler, is hard, a second coat should be applied, and also polished in a similar manner. Oak and all other open grained woods require hardwood filler before waxing. When the wood has been filled, the surplus filler removed with excelsior or tow, and the filler has dried hard, the floor should be sandpapered and the waxing done as above.

The occupants of the house can wax polish such floors from time to time. If it is desired to stain a hardwood floor, the staining is done before filling and the paste filler colored to match the stain. In very fine residences the hardwood floors are filled with paste filler to match the color of the wood as closely as possible, then smooth sandpapered and varnished with one coat of high-grade shellac varnish, again sandpapered and finished with at least two coats of very best floor varnish. For extra fine rooms the last coat of varnish is rubbed or mossed, then polished with rottenstone and sweet oil. In touching up old varnished floors it is best to touch up the bare spots with quick drying flat color to match the remainder of floor in color, then give a coat of floor varnish to which color has been added to match the old color of the floor. The color in this case should be ground in Japan or varnish, and only enough added to stain the floor varnish.

For parquetry floors the best treatment is to apply, in succession, three coats of white shellac varnish, allowing each coat

A PORTABLE ELECTRIC DARKROOM LAMP

W. H. ASPINALL

Herewith is given a drawing of a portable electric darkroom lamp, which I have recently made from scrap materials, some of which had done duty as portions of a gas fitting. The design, it will be noticed, is of a very simple character, and no doubt will be appreciated by those readers who do a little in the photographic line, as it can be made by the average amateur. The flange pedestal and tee-blocks are part of an old gas fitting, and of brass, the tubes forming the rectangle being ½ in. copper. The tee-block at the top was bored out to take ordinary ½ in. nipple lamp-holders; the one at the bottom has a shade carrier and shade, inside of which is a red lamp, the shade itself being of a ruby color, the one on top being an ordinary 16-c.p. plain lamp. Both lamps are controlled by a two-way switch, the current being taken from a fitting by substituting for the lamp an adapter, connected with a length of flexible wire, the whole mounted on a walnut wood baseboard of about 9 in. square (see Fig. 1).—*The Model Engineer and Electrician.*

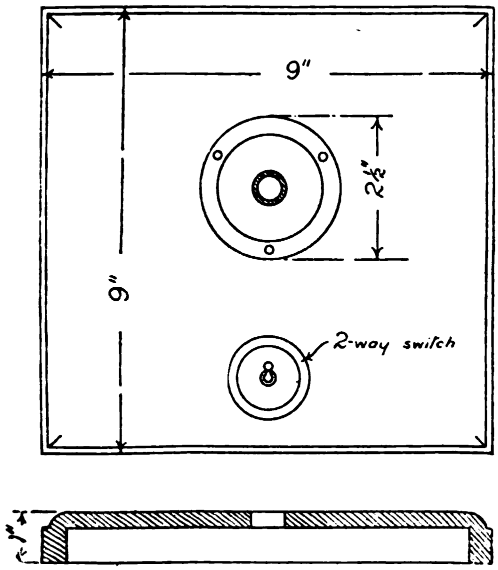


Fig. 1—Section and Plan of Baseboard

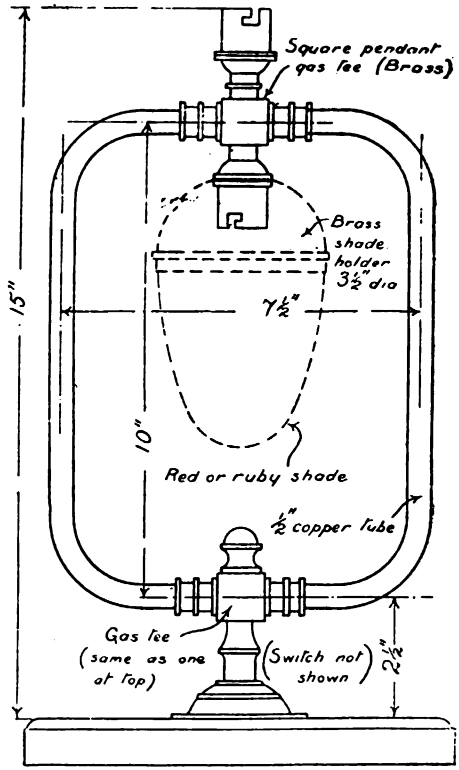


Fig. 2—Front Elevation

Habit is nature multiplied by either a *plus* or a *minus* quantity and either adds to or decreases its beauties and benefits.

Another Aluminum Solder

Another aluminum solder has been added to the already long list now in existence. This time it has been patented by Charles R. Erkens of the Simplex Aluminum Solder Company, Inc., of New York City. The solder is composed of the following:

Tin	60 lbs.
Zinc	15 lbs.
Lead	10 lbs.
Antimony	5 lbs.
Bismuth	5 lbs.
Chromium	5 lbs.

The metals are melted, according to the inventor and then treated with "35 grams of salicylic acid and 10 grams of calcium to each 5 lbs. of the alloy; and for a like amount of material 2 grams of sulphur." The inventor states that the sulphur acts as a "binding agent." The solder is used with the ordinary solder fluxes for soft solder and in the same manner.

A HOME-MADE ATTACHMENT FOR CONVERTING OIL AUTOMOBILE LAMPS TO ELECTRIC

JAMES P. LEWIS

If the auto owner desires an up-to-date car a distinct help is to eliminate the perpetually smoked-up and dingy oil lamps.

While there are several attachments on the market for changing oil lamps to electric, neat and serviceable holders can be made by the owner himself.

The little holder shown in the figure, is the type in which the lamp bulb can instantly be folded back out of the way, and the oil light used when desired. The parts are made of brass, but will have a somewhat better appearance if nickel-plated.

A band *A*, about 1/16 in. thick, and 3/8 in. wide, serves to secure the holder to the oil lamp burner, it being clamped there by a machine screw and nut *B*. One end of the strip is left sufficiently long to project about 1 in. Another short arm, or lever *C*, is riveted or soldered prependicularly to this arm. Another arm *D*, which carries the socket proper, is secured to *C* with a machine screw, as shown in the figure; a short piece of stiff spiral spring being placed between the arm and the nuts, the purpose of this will be seen later. A dent is now made on *D* at *L* heavy enough to show through on *C*, but it must not pierce either. Arm *D* is now turned up in line with *C* and another blow given to dent *L*, so as to mark a second point on *C*, after which the two arms are taken apart and the dents *N* and *K* deepened. Then, as will be seen, the arm carrying the bulb will be held firmly in the two positions, but is instantly changed from one position to another, the principle being the same as that used on some wind-shields. If any other positions of the arm are desired they can be secured by making additional dents on *C*.

Now secure a 3/8 in. piece of 3/8 in. brass tube *F*, also the sheet metal screw from a miniature lamp receptacle, and solder the latter in the former; also solder *F* to the arm *D*. At *H* is screwed a small square of hard fiber; this has a small brass piece screwed to it at *G*. These screws must not make contact with the others.

Two binding-posts can be mounted on the under side of oil lamp, one being insulated and a piece of small flexible-cord run from it to *G*. The other post will make contact through the metal lamp and holder parts to bulb.

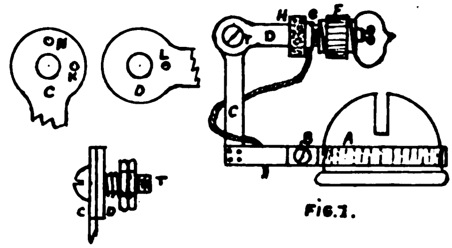


FIG. 1.

The binding-posts are connected through a suitable switch to whatever source of current is available.

Where a machine is not equipped with a storage battery or lighting dynamo, the tail lamp fitted with the above adapter, using a small 4-volt tungsten bulb and a small battery, is both satisfactory and economical.

Lightning Freaks

During a succession of electrical storms at Portsmouth on Friday, August 23, 1912, there was just one lightning discharge at 1.40 p.m., which appeared to be of any consequence. This particular discharge entered the chimney of a house on Congress Street, and after doing more or less damage to the premises, appeared to find the ground through the telephone company's sixty pair aerial cable in the street nearby. The cable was burned completely off and about 7 in. of it entirely disappeared.

Approximately 300 subscribers' telephones were put out of commission. The cable men were soon on the ground, had the cable repaired and about one-half of the subscribers affected were in order at 9.30 p.m. the same day. It seemed strange that this should be about the only damage which this vicinity experienced from these several electrical storms, which covered a period of several hours' duration.

The science of the Microscope is inverted Astronomy and teaches us the immensity of minute things.

A SIX-POINT CIRCUIT-BLOCK

THERON P. FOOTE

The accompanying illustration may at first sight look somewhat complicated, but a little careful study will reveal how simple and extremely useful such a connection of wires and instruments is to the electrical experimenter. All connections terminate at one of the six small binding-posts located on the laboratory work-bench.

Circuits are so connected that the direct-current ammeter always reads in the right direction. The alternating-current ammeter can be connected either way.

Nos. 1, 2, 3, 6, 7, 8 are S.P.D.T. switches; Nos. 12 and 13 are S.P.S.T. switches; No. 4 a home-made rheostat for a bank of lamps in multiple; No. 5, a 12-point switch used as a rheostat for inserting a resistance of one 4- or 6-in. porcelain tube wound with composition wire at the advancement of each point; No. 9, a D.P.S.T. switch; No. 10, a double-arm, three-way, four-pole switch; No. 11, a battery rheostat.

USE OF THE CIRCUIT-BLOCK

110 *A.C.*, use *A* and *B*; No. 2 to right; *Voltmeter reading*, No. 1 to left.

110 *D.C.*, use *A* and *B*; No. 2 to left; *Voltmeter reading*, No. 1 to left.

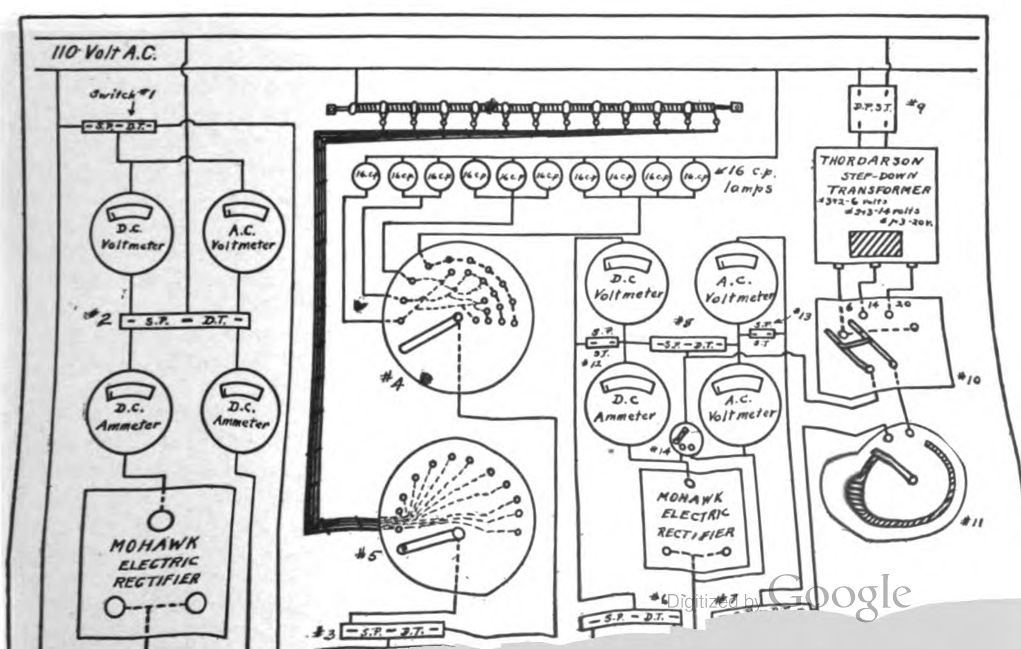
110 *A.C. through resistance coil*, use *B* and *C*; No. 2 to right; No. 3 to left; use No. 5 as rheostat; *Voltmeter reading*, No. 1 to right.

110 *D.C. through resistance coil*, use *B* and *C*; No. 2 to left; No. 3 to left; use No. 5 as rheostat; *Voltmeter reading*, No. 1 to right.

110 *A.C. through resistance of lamps*, use *B* and *C*; No. 2 to right; No. 3 to right; use No. 4 as rheostat; *Voltmeter reading*, No. 1 to right.

110 *D.C. through resistance of lamps*, use *B* and *C*; No. 2 to left; No. 3 to right; use No. 4 as rheostat; *Voltmeter reading*, No. 1 to right.

1-5 *to* 20 *volts A.C. or D.C.*, use *E* and *F*; throw No. 9 on; No. 10 to first position for 1-5 to 6 volts; second posi-



tion for 6 to 14 volts; third position for 14 to 20 volts; No. 8 to right for A.C.; left for D.C.; No. 11 as rheostat; *A.C. Voltmeter reading*, No. 7 to right; *D.C. Voltmeter reading*, No. 6 to right.

For Ampere reading of a battery, dynamo, etc., connect circuit in series with given resistance to *D* and *E*. If D.C. throw No. 12 on and No. 6 to left; if A.C., throw No. 13 on and No. 7 to left.

For Voltage reading of a battery, dynamo, etc., connect circuit directly with *D* and *E*. If D.C. throw No. 6 to left; No. 8 to left; No. 14 to left. If A.C. throw No. 7 to left; No. 8 to right; No. 14 to right.

HOW TO PATCH A CONCRETE FLOOR

When a cement floor surface begins to wear it is often desirable to patch it and the way in which this can be done to the best advantage is described in a recent paper prepared by President L. C. Wason of the Aberthaw Construction Company, Boston, Mass. In this paper he gives the wrong way to do the work as well as the right way, and, says *Building Age*, we present both herewith for the benefit of our readers:

THE WRONG WAY

Commonly a sand and cement mortar is made, some cutting is done and the mortar is put in and scrubbed with a steel trowel until smooth. It is then covered up for a while. If the concrete under the patch is left dry it soaks up the water of the mortar. As a result, the mortar does not set. If the room is dry or hot the surface of the patch dries out and for the same reason it does not set. If the concrete under the patch is dusty, the patch does not adhere to the concrete. If the materials in the mortar are not suitable, naturally the patch wears badly, particularly as it is obviously located at a point of severe wear.

THE RIGHT WAY

Cut down the worn place at least 1½ in. This cutting should be carried into the strong unbroken concrete and the edges should be cleanly undercut. The bottom of the cut should then be swept out, clean-blown out with compressed air or a pair of bellows, if available, then pressed and worked into the surface, which has already been spread with grout. Finally, before the grout is set, a mortar made of one part cement to one part crushed stone or gravel, consisting of graded sizes from ½ in. down to the smallest excluding dust, should be thoroughly mixed and put in place, then floated to a proper surface. Cover with wet bagging, wet sand, sawdust, or other available material. All trucking should be kept off and the surface kept thoroughly wet for at least one week or ten days.

If a particularly hard surface is required, 6-penny nails are sometimes mixed with the mortar and other nails stuck into the surface when the patch is finished. This will produce a surface which is extremely hard and durable.

Copper Production in 1911 Passed High-Water Mark by 17 Million Pounds

The year 1911 was one of prosperity for the copper industry, both smelter and refinery outputs being the largest in its history, according to a report by B. S. Butler, just issued by the United States Geological Survey as an advance chapter from Mineral Resources of the United States for that year.

The average price of copper for 1911 was 12.5 cents a pound, slightly below the price of 1910, but near the close of the year the price advanced, the average for December being 13.71 cents a pound. Metal-market conditions continued to

THE HISTORY OF THE CHRONOMETER

Magnificent Prize Offered by British Government Two Hundred Years Ago Won by John Harrison

An interesting address was given recently before the Manchester branch of the National Association of Goldsmiths, by Mr. J. H. Hobbins, on "The Chronometer: Its History and Use in Navigation."

Mr. Hobbins said that the history of the chronometer in some respects was, perhaps, one of the most romantic stories in the whole realm of invention and science. But before entering into that he asked them to first consider what the chronometer had to do. That might seem a simple kind of question to ask in a company composed of men who were familiar with its details. Still, he thought it desirable for the purposes of his lecture.

Having explained shortly but clearly by means of slides shown on the screen how the mariner is able when on the open seas to determine by the use of the chronometer his longitude and by calculation his latitude, Mr. Hobbins proceeded to say that it was only during the last century that considerable progress was made in the application of the time-piece for the purpose of discovering one's longitude. Of course, there were various other methods of determining longitude without the chronometer, and which need not be mentioned in detail, but not every man who went to sea was versed in astronomy, and therefore the chronometer was used, because by it the mariner could determine right away—without any calculation whatever beyond the simplest arithmetic—his exact longitude, and, of course, from that find out his position at sea.

TAKING THE LONGITUDE

It was about 200 years ago that the government of Great Britain, after many representations had been made, appointed a commission to consider what could be done so that the mariner could more easily and accurately discover his longitude, and the Board of Longitude, as it was designated, offered a considerable reward for a timepiece that would enable the navigator and the mariner to discover their longitude at sea. A sum of £20,000 was offered to the person who devised the most simple method which would enable the mariner to ascertain his longitude to half a degree, or two minutes of time; a sum of £15,000 to be paid for a system which would enable the mariner to determine his longitude to two-thirds of a degree; and £10,000 for one degree. There were a number of conditions attached to the offer made by the Board of Longitude, one being that the test would have to be made on a vessel making a voyage to the West Indies.

The incentive of the large reward, of course, brought many schemes forward to be considered by the committee over which Sir Isaac Newton presided. Some of these were practical schemes and some were so complicated as to be quite useless for the average mariner. Just to show how the matter was then regarded, Mr. Hobbins had thrown on the screen extracts from pamphlets of the period, and also specimen pages from a book published by Richard Locke in 1730, entitled, "The Circle Squared," and "How to Discover Longitude both at Land and Sea by Means of a New Instrument."

EVOLUTION OF THE CHRONOMETER

Now, when one came seriously to consider the evolution of the chronometer, proceeded Mr. Hobbins, it could not be done without mentioning the name of John Harrison, who after forty years' ardent and assiduous labor succeeded in producing a machine which enabled the mariner to determine his longitude with such accuracy as to be really remarkable considering the period. Harrison was the son of a Yorkshire carpenter, and as a young man, when not engaged in assisting his father, filled in his time by making and repairing clocks. As a young man he constructed a clock which was said not to have varied in time more than one minute during a period of ten years. There was no reason to doubt the truth of the story and it was certainly a remarkable achievement in those days. In addition, young Harrison devised a number of other appliances, and one of his inventions was the compensation pendulum, known as the gridiron.

It was some little time after the Board of Navigation had been appointed that

Harrison, probably attracted by the large reward, turned his attention to the matter, and fourteen or fifteen years later he consulted George Graham, an eminent horologist of the time, with regard to a machine he had devised, and there was no doubt that Graham was of considerable assistance to John Harrison and in bringing him to the notice of the Board of Longitude. It was in 1736, something like fifteen years after the passing of the Act, that Harrison submitted his first machine—a very bulky machine undoubtedly—first to the Royal Society, and then to the Board of Longitude. It was tried on a voyage to Lisbon and with considerable success, and Harrison was paid £500 on account, although under the Act the machine had to be tested on a voyage to the West Indies. Some years later Harrison produced another machine, which was much less in bulk, and then commenced the construction of a third machine.

HIGH HONORS FOR HARRISON

The whole matter had been exciting considerable attention in scientific circles year by year, and in 1749 Harrison was considered worthy to be made the recipient of the complimentary medal of the Royal Society. About that time he began to construct a fourth machine, which was now described as a watch. In 1761, after considerable delay on the part of the Admiralty Board and the Board of Longitude, a vessel was commissioned—the *Deptford*—to make a voyage to the West Indies to test the invention of Harrison, who was now getting old and infirm. As he could not make the voyage, his son William was appointed to take his place and have charge of the instrument. In addition to the man-of-war *Deptford*, another vessel, the *Beaver*, was sent out with instruments for the purpose of testing the accuracy of the new machine of Harrison. From the documents published at that time it was shown that Harrison's instrument was in error on the voyage only five seconds of time, which was about a geographical mile. When it was remembered that the *Deptford* was not a modern ship, that was a great success for Harrison, and he became entitled to the large reward of £20,000 offered by the Government.—*The Keystone.*

New York's Waterfront Neglected

ONLY SMALL PART OF 790 MILES OF BEACH AVAILABLE FOR TRADE

Greater New York has a waterfront line of 790 miles. Of this great stretch only a small part has been developed in any way by the city authorities. All attention has been given by the city's engineers to the development of the beach at the lower tip of Manhattan, which has long since been deserted by transatlantic liners for sites farther up the river. They are now in the Chelsea section, where the city has erected a new system of docks. But it took so long to finish the improvement that the steamships had outgrown the piers that had been prepared for their use. These piers are 900 ft. long. The steamships want 1,000 ft. piers and there are but two of this size in the city, and they are in the South Brooklyn section, far from the center of the city, with varying depths of water, inadequate for the leviathans which now ply the ocean.

Although New York is one of the greatest seaports of the world, it is not because it has been made so by improvement, but because it is a natural harbor. For the latter reason business has been crowding in year after year. Commerce has now grown beyond the facilities of the harbor or waterfront, and unless additional dockage is provided it is said that the growth of New York as a seaport will stop and the business that would go there will be diverted to other ports.

What is an accident? It appears to be a simple question, but when applied to industrial conditions in which the responsibility of both employer and employee must be determined, the question presents many difficulties. For example, as applied to railway disasters, collisions, derailments and bridge wrecks have always been termed accidents, but if we apply the usual definition of an accident as an unforseen or injurious occurrence which is not the result of negligence, mistake or intent, then many of these disasters in which reasonable foresight and caution are employed are not accidents at all. The question of what is an accident, therefore, presents certain interesting legal considerations.

GLUED OR FLUSH JOINTS FOR BELTS

C. E. OLIVER

As far as a laced joint is concerned, the hinge butt joint is the only one that will stand the strain of high speed while passing over small pulleys, and also where idlers are in use. I had to go to Chili, S.A., to gain that knowledge from a good Canadian in charge of an American sawmill at the foot of the Cordilleras or Andes mountains. I called to pay this gentleman a visit. He had a planer and tongue- and grooving-machine at work. The driven pulley on the planer was running about 3,000 revolutions, and belt was breaking at the lacing about every other day, causing him much annoyance and loss by shut-downs. I asked him to allow me to apply my English joint, to which he consented, first using the butt joint, four holes in each end, with the straight lace on the underside, and crossed over; but this joint only lasted about an hour. I next tried the double row of holes, taking the lace through front hole in one end and the hook in the other. This only stood the strain about an hour, and if anyone was surprised, I certainly was, for I had not yet learned the lesson of the terrific strain placed upon a belt under the conditions existing in connection with wood-working machines. My friend now applied his old-time friend, the hinge joint, the first time I had ever seen it in my life, and it is good in its place, that is, where small pulleys are in use, and where belts have to run over and under idlers, as it will give and take just like the hinge of a door working in and out.

To make the hinge joint is just as easy a task as to make any other laced joint. Have each end of the belt perfectly square, coming together as a butt joint. For a 5-in. belt punch six holes in a row in each end of the belt, and five ¾-in. holes behind these. Commence lacing in the cent- other words, always bring the lace *up* through each hole, much in the same way that a boot is generally laced. When pains are taken with this joint it can be done very neatly, and is very durable. I have known it to last six months in an 8-in. belt on a roller mill, with an idler in use on the same, placing it under terrific strain.

According to the article by my old friend, W. T. Bates, it does not appear that the British millers are using one of the very best joints—that is, the flush or glued joint, which makes the belt endless. There is, I believe, not a joint made that will compare with it for strength, neatness and easy running, and it runs noiselessly at all times; one may place one's fingers on it while in motion; it may rub against clothing and be harmless. It can be made in a few minutes, and does not require riveting of any kind. I had to come to the United States to find out the way of making the flush or glued joint, and even in America it is not used in many mills—chiefly in those of large capacity. How well I remember the old lap joints that were fastened together with elevator bucket bolts, and what a source of danger they were when running. Woe to the one whose head or any part of his anatomy came into contact with that joint while it was in motion. It was an unsightly, noisy, uneven, and altogether undesirable lap, which ought never to be used on any kind of a belt when there are so many other joints that may be used. Then there was the laced lap, which was another undesirable joint, just as unsightly as the bolted one, and, beside being unsightly, it was inefficient when passing over each pulley by its loss of contact.

To my mind the only fastener which at all compares with the glued joint is

ready for gluing; a small plane, a buffer to scrape and buff the gluing side of each lap; a brush to apply the hot or boiling glue, and a board 3 in. wide, 1 in. thick and 24 in. in length, that is used to rub the joint down after the glue is applied. A list should be taken during the week of each belt needing attention, so that these may be repaired when the mill is closed down, and thus each belt can be kept in perfect condition, and when in motion appears to be endless. The trouble I always encountered with metallic fasteners was their uselessness after they had once been used, and they will sometimes come apart, break, etc., at times when one is least anxious to shut down the mill. It will pay to try glued joints; they are cheap, neat, noiseless, clean and powerful, the joint being as strong as any part of the belt, very easily made, and once used they are always desired. With this belt joint there is no loss of power, as there is a continual contact between belt and pulley, and all that is required to give perfect adhesion is a clean surface obtained by holding a brush against the belt while it is in motion, and then applying half a dozen drops of castor-oil.—*The Miller*.

A HOME-MADE WIRE GAUGE

J. R. BROWN

Having some odd lots of wire and not possessing an up-to-date standard wire-gauge, I have made the following one from odds and ends: *A* is a piece of stout tinplate, 8 x 2 in. *B* is a broken hacksaw blade, or piece of a clock spring, pivoted at *G*. *C* is a piece of brass cut to shape, drilled, and one jaw tapped for setscrew *F* and then sweated to *A*. *D* is also a piece of brass drilled and tapped for ⅛-in. brass wire to be screwed into it and sliding through the left jaw *C*, and abutting *H*, thereby moving the pointer *B*. *E* is a small steel spring. *F* is a steel setscrew to open jaws *D* and *C*. *G* is a steel setscrew for pivot *B*. *H* is a piece of brass sweated to *B*. *K* is a brass nut sweated to *A*. *V* is the vernier.

To calibrate the tinplate, take your divider with *G* as center, and from *G* to the tip of the pointer as radius, describe four arcs; unscrew the setscrew *F*, allowing the sliding jaw *D* to meet the right jaw *C*; press *H* to the end of sliding wire fixed to *D*; where the pointer cuts the arcs call it 0; then screw up *F* till jaw *D* is exactly 1-10 in. from the right jaw *C*; press *H* against end of wire, and where the pointer cuts the arcs call it 10; then divide the arc from 0 to 10 into ten equal parts. Each division will register 1-100 part of an inch. Now subdivide each part into four.

The pointer now will register .0, .0025, .0050, .0075, .01, and so on to .1 or 1-10 in.

To test a piece of wire, insert it between *D* and *C*, turning screw *F* till a sliding fit is made, and then compare the number registered with table of B.W.G. sizes in decimal parts of an inch.—*The Model Engineer and Electrician*.

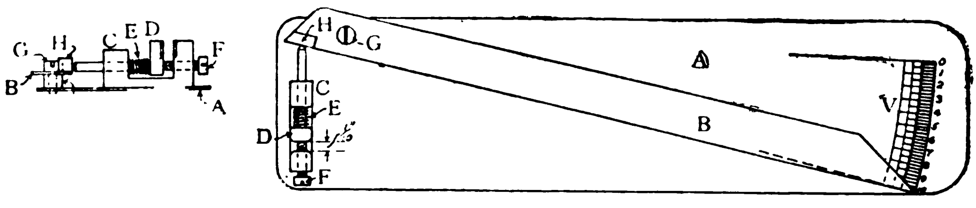


FIG. 1.—PLAN.

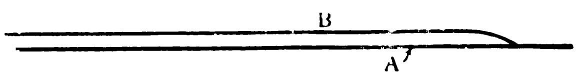


FIG. 2.—SIDE VIEW.

MODERN USES OF THE METAL ALUMINIUM

Its Mechanical and Chemical Properties Readily Adapt It to a Number of Important Applications

RICHARD SELIGMAN, PH.D., in *Science Progress*

Aluminium, which is the chief component of all clays and an important constituent of many rocks, is one of the most widely distributed chemical elements. Despite this fact, it was not isolated until the year 1827, when Wohler obtained the metal in the form of minute gray scales by the interaction of aluminium chloride and metallic potassium. Although this method was improved upon by St. Clair Deville, aluminium did not become a common metal until the simultaneous discoveries of Heroult and Hall in 1887–1888 permitted of its manufacture by electrolysis. The process perfected by these two inventors, which is the only one in use today, consists in electrolyzing a solution of alumina in the molten double fluoride of aluminium and sodium, known as cryolite. The electrodes used are made of carbon and the products of electrolysis are aluminium on the one hand and oxygen and the oxides of carbon on the other. The electrolysis is carried on at a temperature of 950 to 1,000 deg. cent., so that the metal, which melts at 657 deg. cent., is obtained in the molten form.

For close to ten years after these discoveries, aluminium was still regarded as little more than a scientific curiosity, but more recently it has found its way into a rapidly increasing number of industries, for many of which it has become an essential.

RAPID DEVELOPMENT OF INDUSTRY

The rapid development of the aluminium industry is an exemplification of the rule which, though universal, is frequently unrecognized—that supply creates demand. To show that the advance is in this case governed by this rule, it will be necessary to consider the uses to which the metal has been put during the last ton; the amount produced was undoubtedly in excess of the consumption by no small amount, and the makers held considerable stocks of the metal. At that time, the chief difficulty confronting the manufacturer was that of marketing his wares and in view of the hopes which had attended the inception of the industry the outlook was sufficiently discouraging.

However, the time at which the aluminium industry was at its lowest ebb coincided very closely with the first strong impulse given to the automobile trade, which was destined to carry it into the forefront of industrial undertakings. In the early days of self-propelled road vehicles, as at a more recent date in the case of aerial vehicles, every effort was made to lighten the burden placed upon the weak engines which did duty as tractors, and in accomplishing this, advantage was taken freely of the most salient feature of aluminium, its extraordinary lightness. Wherever possible, aluminium was used, whether for engine parts or for the coach work. In a very short time the aluminium makers, who a few months before had been piling stock on stock, not only found their accumulations absorbed, but their factories incapable of keeping pace with the rapidly growing demand. The writer can recall days as recent as 1906 when anxious hours were spent waiting for small consignments of a ton or two of metal from the reduction works to keep the rolling mills going, and when every corner and cranny was searched for bits of old scrap which could be remelted to feed the apparently insatiable motor trade.

IMPROVEMENTS IN PLANTS

Steps were at once taken to increase the capacity of the reduction works and the extension of old and the installa

not wait. Faced by the imperative necessity of finding a substitute for aluminium wherever the latter could be dispensed with, he turned to thin steel sheets, which he found not only far cheaper, but also to his surprise not markedly heavier. He had overlooked the fact that weight for weight steel is stronger than aluminium, so that for many purposes, he was able to reduce the thickness of the metal used to such an extent that no material increase in weight resulted. Moreover, as engine power and efficiency were increased, gradually dead weight began to be of less importance, a process which we can see going on today in the development of aeroplanes. By the time, then, that the cumbrous water wheels, which had been installed all over Europe and America, had been made to revolve, the motor car had swept on its course and the aluminium maker was left with his enormously increased output, but robbed of the outlet for which the output had been called into being.

Thus the supply was created. By 1910–1911 the world's output had been raised to 34,000 tons, and as the power available is now very great and many hydraulic installations which serve other processes would be available, in case of need, for the production of aluminium, the price is half what it was at the opening of the period under review.

WIDENING THE DEMAND

Now as to the demand. Faced by a surplus of metal for which there was no outlet, the manufacturers set themselves to ascertain the fields in which aluminium might best find an application. As a consequence of systematic efforts to educate potential consumers, results have been attained which a few years ago seemed beyond the dreams of avarice. In different countries different lines of action have been pursued. Thus in America the chief new application found have been in culinary ware and the electrical industry; in Germany also the cooking utensil trade has reached enormous proportions, while a most promising outlet has been opened up in chemical apparatus; in France the motor trade still takes a very large amount of aluminium, but a great deal of the metal produced in France finds its way into Germany to feed the industry there, no aluminium being made in Germany, which has to import all its raw metal from other countries. England, characteristically, was long content to send the metal made there abroad rather than go to the trouble either of creating new industries at home or of devoting energy to the studies necessary to enable her to do so. During the last two years, however, a great deal of spade work has been done and foundations have been laid upon which promising business in electrical and chemical apparatus are being built. Moreover, the motor trade, encouraged by low prices, is once more using the metal in large quantities.

In this article it is proposed to discuss the advantages and disadvantages which aluminium has for these purposes and to explain, as far as possible, the causes which have favored its introduction into each branch of industry.

ELECTRICAL INDUSTRY

Owing to its relatively high electrical conductivity, the metal aluminium is now playing an important and steadily growing part in the distribution of electrical power. Taking the conductance of a copper cable of unit cross-section as 100, aluminium of the requisite purity has a conductance of 60, the exact figure depending, as in the case of copper, upon the purity of the metal and its physical state. To carry a given amount of current it is therefore necessary to take a bigger cable if aluminium be used, the cross-section required being 1.66 that of copper. At first sight this does not seem promising, but when it is remembered that the densities of aluminium and copper are 2.71 and 8.95, respectively, it will be seen that the *weights* of cable required to carry the same amount of current will be $1.66 \times 2.71 = 4.50$ in the case of aluminium, and $1 \times 8.95 = 8.95$ in that of copper. In other words, half the weight of aluminium will be required, and as the cost depends upon the weight, and aluminium wire is little more expensive than copper wire per ton, a very large saving in capital outlay is effected by the use of aluminium instead of copper. In the case of bare, overhead conductors, such as are largely used in young countries to convey electrical energy, the full benefit of this economy is felt; and there are, in addition, one or two subsidiary advan-

tages, such as the decreased cost of carriage to the point where the power line is to be erected, usually in remote parts to which the cost of carriage is heavy. On the other hand the strength of aluminium is only half that of copper, but as the area of the aluminium is 1.66 times that of the copper line, the strength of the former is $0.5 \times 1.66 = 0.83$ of that of the former. In consequence the sag between two poles or towers is greater where aluminium is used, and the poles have therefore to be somewhat higher. The general conclusion to be drawn from these various considerations is very favorable to aluminium at the prices ruling today for the transmission of power by means of bare conductors.

ALUMINIUM AND OXIDATION

Aluminium has so far not been found advantageous in cases in which small bare single wires are used, such as telephone and telegraph circuits. The explanation is to be found in chemical and mechanical rather than in electrical considerations. Aluminium when exposed to the atmosphere undergoes superficial oxidation, but this ceases at a certain distance from the surface, the coating formed acting protectively. In the case of large conductors, corrosion does not proceed far enough to cause any trouble, whereas the strength of a small wire may be seriously impaired or the wire may even be corroded throughout its thickness. On the other hand, by using aluminium for large switchboard connections and for "bus bars" for internal transmission of heavy currents in power stations, etc., very considerable economy may be effected. The same advantage does not accrue from the use of aluminium for insulated and armored cables. Owing to the increased diameter of the conductor, the amount of the dielectric or of the armoring has to be increased largely and the additional cost of the latter frequently more than neutralizes the saving made on the cost of the metal. At existing prices, there seems to be a marked saving in the case of single-core cables of [illegible]

advantage attending the use of aluminium for all the purposes cited above is the difficulty of making joints, a difficulty which we shall see later has played so large a part in retarding the introduction of aluminium for chemical plants and one which is not to be not in the way found effective in the latter case. For electrical purposes, joints in aluminium conductors are usually made by purely mechanical means.

Aluminium is said to have been used successfully for battery connections in storage battery installations, but the fact that in such a case it is in contact with the relatively highly electro-negative metal lead in an atmosphere which is always charged with sulphuric acid spray seems to make its use for this purpose particularly inadvisable.

A most interesting and probably very important recent application of aluminium in the electrical industry, based upon its electrical, physical and chemical properties, now claims more than passing attention.

MANUFACTURE OF COILS

The manufacture of coils, whether for motors, dynamos or other electrical apparatus, involves the insulation of each turn of wire from its neighbor so as to insure that the current will pass only along the path ordained for it. One of the greatest problems which the designer of electrical machinery has to face is to get a sufficient number of turns into the space at disposal, which is usually very restricted. As has already been shown, an aluminium wire has to be materially larger than a copper wire, so that if it were necessary to insulate it in the way practised in the case of copper wire (wrapping with rubber, silk, etc.), the use of aluminium would be very disadvantageous. Aluminium, however, has a chemical property which has been pressed into the service of the electrician in a most ingenious manner. The surface of the metal is normally covered by a thin, invisible coating of oxide. By immersing the metal in suitable solutions.

machinery which, according to Mariage, show a saving in weight of about 50 per cent., which, owing to the position of the coils in electrically propelled vehicles is a saving of very great moment, and a reduction in cost of 60 per cent. Moreover, unlike the usual insulating material, being entirely inorganic, the coating made on aluminium is improved rather than damaged by heat, so that the danger of burning the insulation and so short-circuiting the coils is diminished. On the other hand, the size of the coil must still be somewhat larger and the difficulty of making effective joints is greater than in the case of copper. Such coils have not been in use very long, but their application seems to be increasing very rapidly and the writer is of the opinion that their ultimate adoption on a very large scale is assured.

Space does not allow of a detailed discussion of the use of aluminium in other directions in the electrical industry, and mention can therefore only be made of such articles as current collectors on electric railways, fuses, lamp fittings, meter cases, lighting interrupters, etc., for all of which purposes aluminium is now in use to some extent.

In conclusion, it may be said that the very large development which is taking place in the introduction of aluminium for electrical work represents no mean achievement. Unlike some of the industries which will be considered later, the electrical industry was quite satisfied with copper and did not realize that the advantages which have been enumerated were attainable. It has been led to appreciate them by an enlightening propaganda which benefited both the industries concerned.

TRANSPORT VEHICLES

The rapidly growing use of aluminium in the construction of vehicles is based on several distinctive properties of the metal and its alloys. Before dwelling on these, it will be well to enumerate the actual uses to which the metal is being put. The principal users are the motor-car builders, who have applied the metal to making panels and moldings of carriage work, in the construction of the jackets and crank-cases of the engine, ium in railway coach building, in which it is used only for panelling and in still rarer cases for door handles and similar minor fittings. In the case of aerial vehicles, aluminium is used in constructing seats, shields, instruments, cases, and, in fact, wherever lightness without strength is required. Formerly aluminium was used in making the joints between members of the frame, but this use of aluminium seems to be dying out; the classic cases of the Zeppelin airships and the Barrow airship represent isolated instances of abortive attempts to use aluminium and its alloys for constructional purposes in aerial work.

From the above it will be seen that aluminium is used either as sheet metal or in the form of castings.

Aluminium sheet was originally used for panels on account of its lightness. Today a more important property of the metal is its extraordinary malleability, by reason of which panels of complicated shapes may be beaten out from it more cheaply than from thin sheet steel, unless a large number of similar panels are to be made, in which case costly machinery can be installed for the purpose. The surface of a well-made aluminium panel is also better than that of one made of steel, while wood, owing to the shrinkage which it undergoes, the amount of paint it absorbs and the difficulty of working it, is no longer used for motor-car work.

The advantages accruing from the use of aluminium for the purposes mentioned are not sufficiently marked, however, to induce makers to employ it unless the price of the metal be very low. It has been seen already that when the price rises appreciably, aluminium is discarded in favor of steel, but at prices obtaining at the time of writing, aluminium panels are being used to a large extent.

ALUMINIUM CASTINGS

The case of aluminium castings for engine parts is very different, as the advantages the metal has are very conspicuous, and be the price high or low, very little else than aluminium is used. In the first instance, the saving of weight is very considerable, as such castings are of necessity bulky, and if made in

Pure aluminium is not used for this class of casting. When unalloyed, aluminium does not run at all well, and in consequence small passages in the mold may not be well filled. Moreover, it often happens that portions of the molten metal which meet in the interior of the mold do not unite, owing to the skin of oxide which covers their surfaces. Aluminium itself also lacks the necessary rigidity and the shrinkage of the metal on solidification (1.8 per cent.) makes the production of sound castings difficult. Recourse is usually had to alloys containing about 10 to 12 per cent. of zinc and 2 to 3 per cent. of copper. These alloys have the properties which aluminium itself lacks, and are more suitable even than other metal for the production of castings of intricate pattern. If the percentage of zinc be increased to excess, the castings are apt to break when exposed to continual vibration. In earlier days great trouble was experienced on this account, but when the enormous number of castings in daily use is borne in mind, the number of breakages now occurring must be considered trifling.

HOUSEHOLD AND TRAVELING UTENSILS

In discussing the application of aluminium to household purposes, traveling and military equipments, properties of the metal have to be considered which are of no account in the cases previously considered. The use of the metal for such purposes depends in the first instance upon the fact that compared with the materials heretofore used in kitchen and camp, aluminium is either infinitely safer from a hygienic point of view or far more durable. In this case comparison lies between aluminium on the one hand and iron, copper, enameled iron, and tinned iron on the other. For heavy cooking utensils, such as large kettles and heavy pans, iron still holds the field. Iron vessels, however, can be used only for a very limited number of purposes, and are unsuitable for general use, owing fact that copper salts are most active poisons. Copper vessels, therefore, are coated with a thin layer of tin. This precaution is by no means sufficient to eliminate the danger, because the tin sooner or later wears off. Moreover, the cost of copper vessels is more than the purse of most housewives can bear and the cost of retinning is a permanently recurring charge. In point of price, aluminium cannot bear comparison either with tinned or enameled iron, but the life of the former is so very short that it does not form a serious competitor. Enameled iron may and frequently does give satisfaction on this score; on the other hand, it is entirely untrustworthy, and in case of damage to the enamel it is the most dangerous material which can be used. There is in this case no question of poisoning, as with copper, but chips of enamel become intermixed with the food, and probably are the cause of disorders such as appendicitis, etc., more frequently than is supposed. From all these disadvantages aluminium is absolutely free. Drawbacks of its own it has, but these are distinct from those cited above. Aluminium is second only to copper among the common metals in thermal conductivity, and gives no color to the finest materials. Dirt is seen so easily upon its white surface that it is possible to tell at a glance whether it be clean or not. In addition to the fact that it dissolves but slowly in weak organic acids is the immensely important fact that even in solution it is entirely innocuous. Unlike tinned copper, tinned iron, and enameled iron, it is uniform throughout its thickness, and consequently there is no coating to wear off, crack, or chip. Having these advantages, the question may well be asked, "How is it that its use is not universal?" The reasons are three in number. The cost of aluminium still places it above the reach of the poorest; the aluminium formerly used for the purpose was inferior; lastly, the metal cannot be cleaned

ganic acids is small, and if it took place generally over the surface of the metal, it would be negligible. Unfortunately, however, this is not the case. The presence of small impurities in the metal or even of physical differences between adjacent particles may lead to local dissolution and pitting or perforation of the metal. Owing to improvements in the methods of manufacture, the former trouble has been largely obviated, and since the recognition of the importance of the physical state of the metal, still further improvement may be looked for. As a matter of fact, the degree of progress which has already been attained is very remarkable. In America and in Germany, millions of cooking utensils are made annually, and the percentage of returns is nowadays very small indeed.

Now as to the third difficulty.

Aluminium unfortunately is readily attacked by alkalis and, therefore, the cleansing agent of the kitchen, soda, is one of its worst enemies. As a consequence, the cleansing of aluminium must be effected mechanically and entails appreciably more labor than if effected in the customary manner by means of an alkali. This is the chief difficulty which remains to be overcome. In Germany, where the "hausfrau" herself takes pride in the appearance of her kitchen and herself does much of the cooking, it has not been sufficient to counteract the obvious advantages the metal has. One German factory known to the writer used in 1910 about 3,000 tons of aluminium, almost all of which was made into kitchen utensils. In the United States a huge business has been built up, mainly by the exertions of university students, who in their long vacations were engaged to educate the public to appreciate the advantages of aluminium; while even the Indian "ryot," who has always cleaned his pots and pans by polishing them with sand, is rapidly learning to substitute aluminium for the brass bowl prescribed by immemorial custom. Only in England is progress slow, mainly, in the writer's opinion, because in England the housewife does not cook, and is not mistress in her own kitchen—where she walks in fear and trembling—and because no one has arisen who has had the courage to undertake the education of our national institution, Mary Ann.

In addition to the advantages cited above, the lightness of aluminium is the cause of its wide use for the field equipment of soldiers and travelers, to whom every ounce saved in the weight of water-bottle and cooking-pot is of importance. Moreover, the malleability of the metal renders it practically unbreakable, a factor of no small consequence when the treatment to which field equipment is subjected is borne in mind.

The properties which have rendered the success of aluminium in the kitchen possible are also those upon which its claims as a material for the construction of chemical plant are based. This is true more especially of apparatus suitable for use in foodstuff factories, which have been erected in such large numbers during the past two decades. A modern jam factory, an extract of meat factory, a cordial factory, is each but a domestic kitchen magnified a thousandfold, a well-equipped condensed milk or margarine works being but the apotheosis of a dairy, where purity of taste and color and freedom from infection must and do reign supreme.

Dr. Strauch, a mental specialist, has discovered a new disease which he calls telephone nervousness. A prominent Berlin attorney had been in continual conflict with the Post Office for more than a year regarding his telephone. Several times he was prosecuted on the charge of insulting the telephone girl and finally his telephone connection was cut off. The attorney immediately began proceedings for its restoration. The Post Office Department offered as a defence that the attorney was continually insulting officials.

Dr. Strauch was called as an expert and testified that telephone nervousness was a serious ailment. The telephone, he said, acts on certain persons like poison. He continued: "I know a case in my personal practice of a physician who was so worked up by delays and other unpleasant occurrences that he became permanently insane. Excitable persons should never use the telephone."

The court was so impressed that it adjourned the case in order to enable Dr. Strauch to submit further instances of the disease and observations as to its effect.

ELECTRIC LIGHT AND ALARM SWITCHBOARD

W. T. JOHNSTON

I am sure that most of the amateurs who take up the hobby of electricity would like to make something that would be of good service to them, and something that would show what they could do.

The idea of this board is that by setting the electric clock alarm at the hour you wish to be awakened, the clock bell rings for a few seconds, stops, and then the large bell rings and continues ringing until switched off from the board; then again, you have the electric light, which you can switch on from a flexible wire push whenever you wish to see the time.

As regards upkeep expense, this should not be any hindrance to anyone who is desirous of making such a useful article, for, with usual care, the cost per year does not exceed ten cents—the price of 1 lb. of sal ammoniac.

First, obtain a piece of wood, 2 ft. ½ in. x 12¼ in. x 1¼ in. This can be either African mahogany or ordinary white wood, which could be stained and varnished by any worker himself; as for the fancy beading around the edge of the board, this is a matter of taste, as it would look quite as well by half-rounding the edges with an ordinary wood file or plane. Then obtain another piece of wood 7⅜ x 3½ x ½ in. for the clock-base; the corners of the shelf should be cut away or rounded. This completes all of the woodwork.

Now for the remainder of material, which can be purchased from any of the well-known electric firms, such as those whose names appear elsewhere in this magazine.

One swan-neck bracket, with shade; also a joint to take the bayonet cap of the lamp.

Two brass terminals (telegraph pattern).

One electric lamp, 2 volts.

One electric alarm clock.

One electric bell (door-bell pattern).

One rosette with flexible wire push.

One small switch 2¼ x 1⅜ in.

Two complete Leclanché batteries.

Two small iron brackets for clock shelf.

Red and blue bell wire, equal lengths; length according to distance from battery to board.

The items of lamp and batteries can be increased if a stronger light and louder bell be required—say 4 volts; this gives a sufficient light and ring.

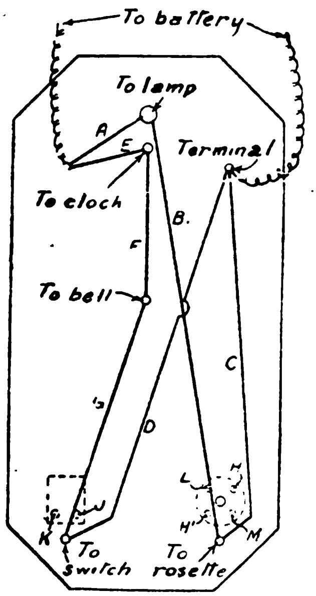


Fig. 1

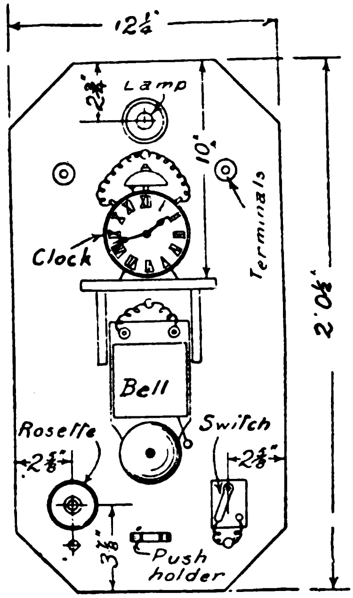


Fig. 2

Front and Back Views, Showing Connections

Now for the fixing up and wiring: Measure down the board 10 in. (see diagram, Fig. 1) and screw on your bracket and shelf to hold the clock. (The brackets should be wide enough to place the bell between.) In the exact center of the board measure down 2¾ in. and bore a hole to admit wires to the lamp; then, from the lamp hole, measure down 2½ in. and draw a faint pencil line across, so as to allow you to bore the two holes, one on either side. On the exact center of horizontal line bore a hole for the wires to the clock, then below that again in the center of the board measure down 6¾ in. from the clock hole — this brings you below the clock bracket—and there bore a hole for the wires to the bell. From the bottom of the board measure up 3⅞ in. and draw another faint horizontal line, so that you will have the push rosette and switch in line; measure from the left-hand side 2⅝ in. and bore a hole to admit the wires to the rosette, and on the right-hand side measure 2½ in. up and bore another hole for the switch. All the holes are to be ¼ in. in diameter.

Now you have everything ready to fix up the wires temporarily, and if you are careful in following out the instructions for wiring, you can see if it is working to your satisfaction before proceeding to stain and varnish the board and fix up for good.

The wiring (see diagram, Fig. 2) is the most particular part about the whole thing, and it will be necessary to follow out the directions very carefully. First you take the two different colors of wire and from the blue wire cut one piece 15 in. or 16 in. long (wire *A*) and fix from left-hand terminal at back of board through hole for lamp, and with another piece of blue wire, 21 or 22 in. long, *B*, put through the hole at right-hand bottom of board through hole for lamp;

Now for the red wire. Cut a piece 10 in. long, *E*, fix on left-hand terminal across through hole for clock and coil the two ends as shown in diagram; you can coil the wire by rounding through a pencil. Cut another piece of red wire *F*, from clock hole again, leading down through hole for bell, cut one other piece of red wire, *G*, from hole for bell (coil the two wires in front of board, as already done for clock), down through hole for switch, and fix in binding screw *K*. This completes all the back wiring.

Now let us turn to the front of board to complete the wiring. You will see we have just the two red wires for clock, then below that again (below bracket) other two coiled red wires. Fix these to the bell terminals, then go down to the rosette. We have still two binding screws vacant, *L* and *M*, on which we fix the two wires from push. Now this completes all wiring for board; now the only remaining two wires are from battery, and on charging the battery in the usual way with sal ammoniac, join up battery as shown in diagram; carry your two leading wires—red one from carbon of battery right up and across front of board to left-hand terminal; and the other (blue) wire from zinc of battery up and across to right-hand terminal.

Now, if you have followed out the instructions carefully, you will find you have a most useful and interesting instrument over and above having learned some wiring. I may say, however, the above instructions are all that are necessary; only you may improve the look of the board greatly by adding a few extra things, such as a small brass wire holder screwed into center of board at bottom, to hold the push. Then again, should you fix the board close to the bedside, the ticking of the clock sometimes annoys one, but this can be easily ... felt,

A WIRELESS TELEGRAPH EQUIPMENT FOR A SMALL CRUISER

B. F. DASHIELL

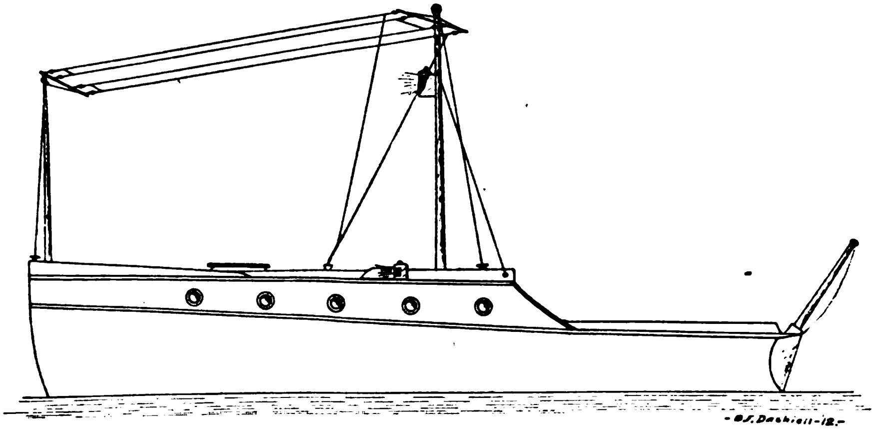


Fig. 1—Aerial Masts

It is the purpose of this article to give in as simple and concise a manner as possible the necessary information on the construction of a wireless telegraph station to be installed upon any type of cabin cruiser, either sail or motor. A wireless telegraph station installed on board a small boat will be of great use not only in case of dire necessity, but also to get the weather reports and news from local land or ship stations. This station has a positive receiving range of 50 miles in the day and over 100 at night. The writer has taken it for granted that the average reader has some knowledge of electricity and the principles of wireless transmission, so that he need not go into detailed explanation.

First, we will take up the construction of the aerial. This is composed of four No. 14 B. & S. gauge bare copper wires, and are so arranged as to be strung up above the deck of the boat as shown in Fig. 1. As all cruisers have a mast or two, they can be well utilized to support the aerial wires. If the mast can be lengthened it will be much better, as a higher aerial means increased range. Try to have both ends of the aerial of the same height so as to keep the aerial horizontal. The length of the wires depends upon the distance between the masts. If only one mast is used, have one end of the aerial come down to the bow or stern of the boat, that end which is the greatest distance from the top of the mast, so as to get the aerial as long as possible.

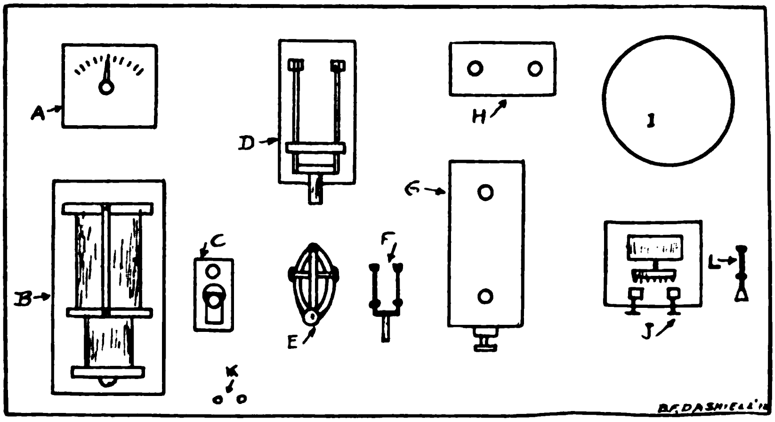


Fig. 2—Layout of Table

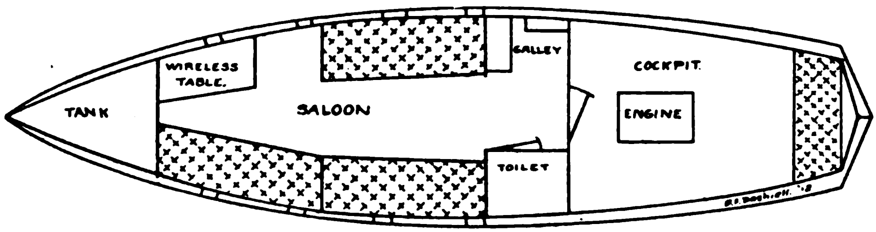


Fig. 3—Showing Wireless Table

Two light wooden spreaders will be needed, each 6 ft. long. Holes are bored in them so as to separate the wires by 2 ft. To assemble the aerial, cut the four wires of the correct length; fasten them to hard rubber high-tension insulators which are then fastened in the holes of the spreaders. Connect all the wires together so as to form a continuous circuit, as shown in Fig. 1. The two free ends of the wires are connected together at a distance of about 1 ft. from the top of the cabin roof. These two wires are soldered to a No. 10 rubber-covered, high-tension cable, which passes down through a hard rubber bushing in the cabin roof. This lead-in must go direct to the aerial switch. Solder all joints well, using resin as a flux.

If the boat is equipped with a 110-volt dynamo for lighting service, a high power station can be installed. If not, storage batteries furnish the necessary current. The battery should have a capacity of 60 ampere-hours at a pressure of 12 volts. If the 110-volt current is used, the transmitting set will use either a ½ or ¼ k.w. transformer, this depending upon the capacity of the dynamo in amperes. If the storage battery is used, either a 3 or 2 in. induction coil is used. The coil should be one designed for wireless use. The transmitting distances of the various coils are: ½ k.w. 20 miles at day, ¼ k.w. 12 miles; 3-in. 8 to 10 miles, 2-in. 5 to 8 miles. At night the distances will be almost twice as great. The sizes of aerials, weather conditions, types of instruments used, all will have some influence on the sending and receiving distances.

The entire transmitting set is composed of the following: ½ or ¼ k.w. transformer; 3 or 2 in. induction coil, oil condenser of the correct capacity to go with the coil used, ribbon-wound helix, rotary spark gap, key and aerial switch. The rotary spark gap is preferable, inasmuch

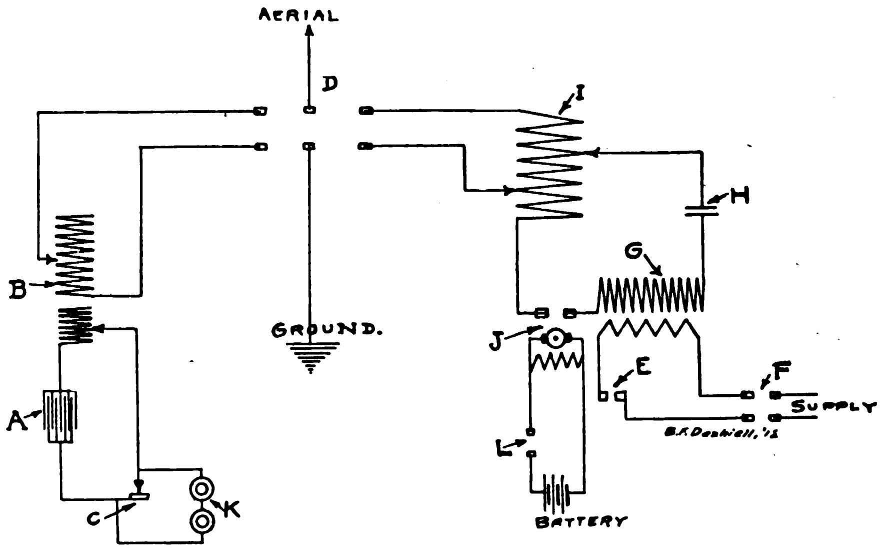


Fig. 4—Wiring Diagram Showing Connections

that it will increase the range materially and heighten the pitch of the spark, thus making it more easily read through static and interference. This gap will operate on about 4 volts and ½ ampere. Use high-tension cable for all secondary wiring and plain insulated wire for other wiring.

The receiving set is composed of the following, and has been found by the writer to be very efficient with small aerials. One loose-coupled tuning coil, silicon or ferron detector, variable condenser and a pair of reliable telephone receivers.

Fig. 2 is a plan of the wireless table with the instruments arranged upon it. *A* is the variable condenser, *B* the tuning coil, *C* the detector, *D* the aerial switch, *E* the key, *F* the battery switch, *G* the transformer or coil, *H* the condenser, *I* the helix, *J* the rotary spark gap, *K* the telephone connections, and *L* the switch to control the rotary spark gap.

The transmitting set is put on the right-hand side of the table and the receiving set at the left. The key and aerial are so placed as to be easily operated. Fig. 3 shows the situation of the wireless table, but it can be arranged to suit the shape and size of the cabin or boat. It is best to have it in a convenient and yet out-of-the-way place. The ground wire, a No. 8 B. & S. Gauge, is soldered to the engine frame or metal hull of the boat. In case of a sail boat and having no metal hull, solder the wire to the rudder support. Fig. 4 gives a wiring diagram which shows the connections of the sending and receiving instruments.

The writer suggests to those who contemplate the installation of a wireless set on their boat, and are not familiar with the operation of the instruments, that they get a copy of some good wireless text-book that will not only give the explanation, but the actual construction of the instruments, as this latter item will prove a great help in the study of wireless telegraphy.

A "Master" Wireless Clock Promised for the Future

Cosmos of Paris says that dial clocks operated by wireless waves soon will take the place of the ordinary electric clock-dial, connected by wire with a central "master clock." This requires separate wiring and on this account is expensive. "There are watch factories in Switzerland that receive the exact hour from the Eiffel Tower daily," says *Cosmos*, "but the communication of the time, minute by minute, to numerous clocks by electric waves is an entirely new and unexpected fact. A sufficient power must be given to the electric wave to permit of precise action, and receiving clocks must be so built that the hand will make only one advance movement in a given time, to avoid all disturbing influences from outside sources of electricity. Finally, all hertzian waves not coming from the sending apparatus must be neutralized. All these difficulties are solved in the system of Mgr. Cerebotani of Munich, well-known for his work in electro-technics.

The experiment would appear to be very simple. On a table is placed an ordinary clock, marking seconds, in communication with a relay and a dry battery operating a wireless sending apparatus. On another table is a receiving antenna connected to a clock which, instead of the ordinary clockwork, contains an electromagnet and a relay of special construction. As soon as the second-hand of the first clock has made its round of the dial the antenna sends out a wave that operates the minute-hand of the receiving clock, or of several such, causing it to advance by one division. The only difference between this device and an ordinary electric clock consists in the absence of a connecting wire. A sending clock placed in any central position—on top of a tower, for example—and provided with an antenna similar to those used in wireless telegraphy, can thus send out the exact time to a great number of public clocks, located in squares, restaurants, offices, etc. A fact worthy of remark is that the new receiving clocks cost not more than $3.00, according to Mgr. Cerebotani. He proposes to deliver lectures in various European cities to enable specialists to form an opinion of his invention."—*Keystone.*

Three barleycorns make an inch, so the table says, and three drinks of barley juice sometimes make a riot.

A CHUCK FOR OVAL TURNING IN THE LATHE

THOS. W. PLANT

Following is a description of my oval turning chuck for the lathe, which is fitted to an ordinary cast-iron slotted faceplate, and can be made by an amateur at a very trifling cost. The accompanying illustrations are for a 2½-in. center lathe; but the chuck can be fitted to one any height by making the support of the guide ring sufficiently high to bring the center of guide ring in line with center of mandrel when pushed back. The faceplate (preferably one with a small boss at the back) must be screwed on mandrel and faced up true and straight across the face, being constantly tried with a straight edge, as the chuck will work much steadier if true, and prevent the outside plate from rocking when at work. Now get the exact center, and draw a line through center and across

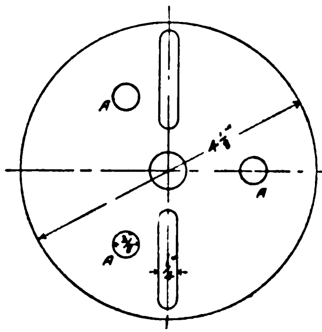


Fig. 1—Faceplate.

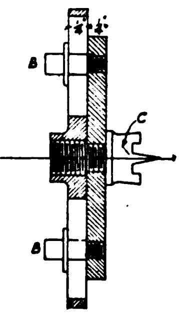


Fig. 2—Section X. Y.

the exact middle of the two slots in faceplate; then space out equal distances on each side of the line—say, ⅛ in.—and clean out the two slots with a file to the line, to make grooves for the studs to slide in; take off faceplate, and either reverse on the mandrel and turn up equal

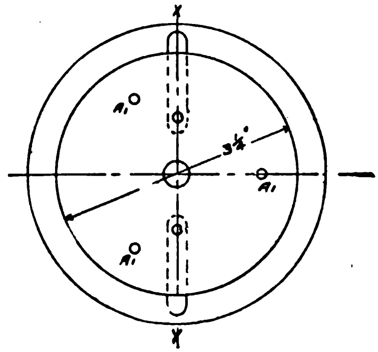


Fig. 3—Chuck

center of the hole exactly in a line with the center of the plate.

Now with two short screw pins, screw the brass plate to faceplate from the back of same, through the slots, setting it roughly near the center, and turn up the face of brass plate flat across to straight edge. Now take off the faceplate, and refix with the same screws the trued-up side to the faceplate, and turn up what is now outside, making a truly parallel plate 3½ in. in diameter. Now turn the outer edge circular, and at right angles to face to 3¼ in. diameter; while still on the faceplate turn out a hole in center to be tapped for insertion of forked chuck *C*, Fig. 2, for holding such things as bradawl handles, etc.; drill three ⅛-in. holes *A*1, Fig. 3, so that they come over the ⅜-in. holes in cast plate. These are for screwing on the work.

Take off the faceplate and fix a piece of ⅝ in. diameter iron rod in lathe not less than 4 in. long, and turn out two screw blanks, as *B*, Fig. 2, the long ends to be turned a good fit to slots of faceplate, and sufficiently long to reach

through both the faceplate and the brass plate, the other ends to be turned long enough to reach well over guide ring; slot the ends for screw-driver, thread the long ends just enough to reach through brass plate. These screws should fit well in brass plate so as not to get shaky when in use.

The guide ring, Fig. 4, is made of a piece of iron or brass 5/16 in. thick, turned nicely to make a smooth fit within the two studs *B*, Fig. 2; when screwed into the sliding plate you now require a circular piece of iron 1/8 in. thick, slightly smaller than guide ring, as shown by dotted line, Fig. 4, for packing guide ring from support. The support can be made of iron 1/8 in. thick by 2½ in. wide, bent up at right angles about 1 in. from the end. Cut a slot in the bent part, as shown at *D*, Fig. 4, from the center towards the back

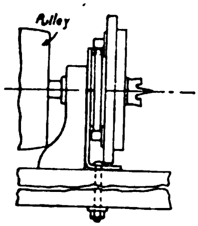


Fig. 5—Complete Chuck on Lathe Mandrel

when on the lathe, the slot to be made about 1 in. long and to fit a ¼ in. pin going through between the lathe bed to screw up underneath with washer and nut; push up support to nose of mandrel, and drill a hole for mandrel to come through; get a piece of wood or metal and fasten to mandrel, and with a striking point fixed in the wood the same diameter as guide ring, mark the exact place for riveting the ring, packing-piece, and support together, taking great care to get the center of guide ring and the center of mandrel the same height; take support off lathe bed, rivet all together, and finish by cutting out oval hole *E*, Fig. 4, extending nearly to the back of ring.

To use the chuck, join all parts together. the material more or less oval, according to position of guide ring. With a piece of wood fixed in forked chuck at one end, and held up with the back center, some nice turning may be done, as bradawl handles, hammer shafts, etc. If you want to turn short objects oval throughout, you fix your wood, etc., on brass plate with screws through holes A1, Fig. 3, without taking off cast plate. When turning you require to keep the tool at one fixed height to get the best results. This is an easy matter with a slide-rest.

Electric Timing at the Olympic Games

At the Olympic games at Stockholm there was used a novel electric method for timing the runners in some of the races, so as to get the exact time made by the winner, and also to decide who crossed the line first, even when the difference was very small. The starter gave the signal by firing a pistol, and this was connected by electric wires with two stop watches and these commenced to run for taking the time. The start and finish were at the same point, and across the track a light string was stretched between poles and the string was also connected with the stop watches for stopping them. The first comer broke the string when crossing the line so that the watches were stopped and the exact time between start and finish could be seen. Breaking the string also served to work an electric device for the shutter of a camera which was mounted just on the finish line and above the judges' stand, so that the photographer had an image of the winner when crossing the finish line. This method is very useful in settling all disputes.—*Le Nature, Paris.*

Soldering Irregular Pieces

To solder together, accurately, irregular pieces of metal or the two parts of a broken piece, impress the parts into a lump of putty placed on a piece of tinplate. Having thus formed a mould.

AN ARMCHAIR

An armchair is not the easiest piece of furniture to make, and on account of its difficult mortise and tenon joints, is rarely attempted by the amateur. The design given in Fig. 1 is about as simple as it is possible to make one; the chair is comfortable, an important point, contains a very little upholstering and there are only eight very simple mortise and tenon joints, two lapped halving in the framing and two joints in the arms. First of all, prepare two 25 in. lengths of 1½ in. x 1½ in. wood, one 26 in. and one 14 in. length, see that they are quite square and true, and then prepare two 23 in. and two 18 in. lengths, 2 x 1 in.

ERECTING THE FRAMING

These pieces are fitted together, as shown in Fig. 4, and in detail in Figs. 5 and 6. First of all mark off in the middle of the 2 x 1 in. length, a groove exactly 1 in. wide and deep, and then saw down inside the marked lines and space out the waste, as shown in Fig. 5. Now fit one 23 in. and one 18 in. length together, and test if they are square, for this is important. Next mark off on the long arms exactly 9 in. each side of the slot and on the short arms, 6½ in. on one side and 6 in. on the other; these lines will form the shoulders of the tenon, as shown in the section, Fig. 6. Next gauge a line ¼ in. each side, and then saw down with a tenon saw to the shoulders and cut off the waste. We must now mark off the joints in the uprights and from the end of each 1½ in. length, mark off exactly 4 in. and then 2 in. and carry the lines in pencil right around the wood with a try square.

Now at 12 in. up from the same end mark another set of lines, and another 2 in. higher up (in one length this will be at the top). In the two 25 in. lengths saw down as shown in Fig. 7, and pare out the piece, making the width of the cut exactly 1 in.; three or four 7/16 in. centerbit holes should now be bored right through and the sides pared down to make a mortise of ½ in. wide. This should be done in four cases. In the short length and the 26 in. length, the mortises are on one side, a line being marked off ¼ i... prepared. This should, if possible, be in one piece, 16 in. square and 1 in. thick, plane it up carefully and draw lines across from corner to corner. The curves should be marked out with a radius of 7 in., the center of each being 1½ in. from the middle of the wood. Cut off the waste and spokeshave to the line and then cut out the slots, as shown in Fig. 8, and fit the seat in, just rounding off the front edge. The arms should now be made, a 2 ft. 4 in. length of 4 x 1 in. wood being required. The method of marking out is shown in Fig. 9, and the arm piece cut to shape and spokeshaved in Fig. 10. The corners should be carefully rounded off to suit, a curve of ¾ in. radius being most suitable. The arms are fitted in a slot, or groove, cut in the back upright 1 in. from the top and fitted on the outside uprights with the mortise and tenon joint shown, going right through or within ¼ in. as preferred, the former method being more simple.

The rails of 5 x ¾ in. wood should be 9½ in. long and fit in slots cut out to a depth of ¼ in., as shown in Fig. 8.

The framework should now be glued up and bound together with strong string pulled up taut, taking care to protect the corners with thick cardboard, and then screw the seat to the top cross pieces.

THE FINISHING TOUCHES

The work should now be stained, polished, or enameled, and when quite hard the seat may be upholstered. We shall now require a little well curled horsehair. Probably ¼ lb. would be sufficient, but this depends on the give of the material used for covering; a 15 in. square piece of canvas or calico and a similar quantity of leather, pegamoid, or tapestry, about 1¾ yds. of gimp or leather banding and 3 doz. studs. Commence by tacking on the canvas 1 in. away from the two back edges and stuff that part with hair. Gradually tack up the front portion, stuffing the hair up tightly as the seat is covered. Now cut the leather or tapestry to shape and tack in position, and then put on banding or gimp and knock in the studs at intervals of 1 in. or so. This method of upholstering is not

FIG. 1.

IDEAL HOUSE FURNITURE.——An Arm Chair.

1. The completed chair. 2. Front elevation. 3. Plan. 4. Framing from front. 5. Lapped halving joint in crossbars of frame. 6. Mortise and tenon joint (section through leg). 7. Method of cutting mortise in leg. 8. Seat. 9. Method of marking out the arm pieces. 10. One piece for arm shaped.

MATERIALS REQUIRED.

8ft. run of 1¾in. by 1¾in. finished size. One piece 10in. by 16in. by 1in. finished size. 7ft. run of 2in. by 1in. finished size. 2ft. run. of 5in. by ⅞in. finished size. 2ft. 4in. of 4in. by 1in. finished size. ¾lb. horsehair. 15in. square of canvas and tapestry or leather, 1¾ yds. gimp or banding, 3 doz. studs and screws, tacks, stain, &c.

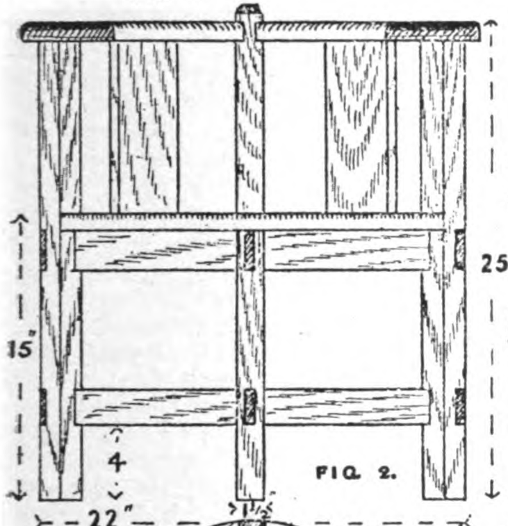


FIG. 2.

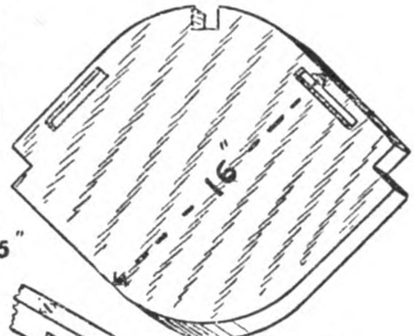


FIG. 8.

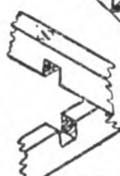


FIG. 5.

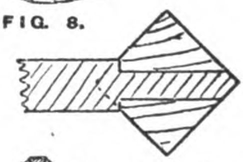


FIG 6.

FIG. 7.

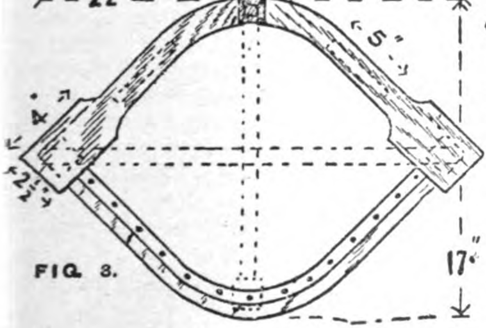
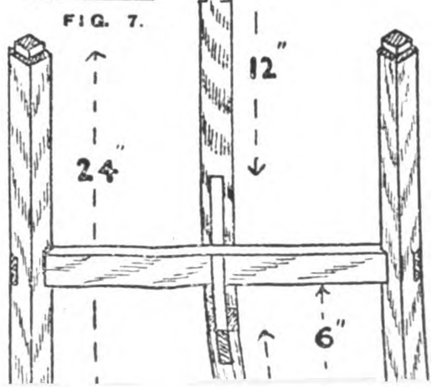


FIG. 3.



A DOOR LETTER BOX

This useful letter box, which is shown complete in Fig. 1, is suitable for fitting to a street door. The box may be fixed at any convenient height, and a slit, through which the letters may be passed, must, of course, be provided in the door, while a small door is fitted at the bottom of the box by means of which the letters may be removed. Fig. 2 shows a sectional perspective view of the box; Fig. 3 shows an end view, and gives the principal dimensions; and details of the construction are illustrated in Figs. 4 to 8.

Yellow pine ½ in. thick will be a very suitable wood to use in making the box.

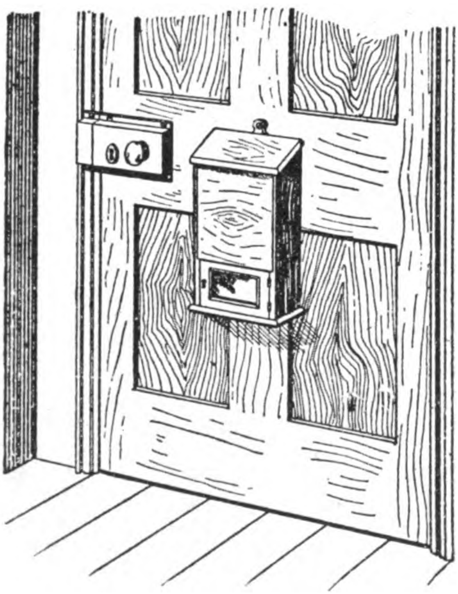


Fig. 1

The first consideration will be the sides *A*, and the top and bottom *B* and *C*. The sides are cut 1 ft. 4½ in. long at the back, and 1 ft. 2½ in. long at the front, by 5 in. wide: and the top and bottom are 8½

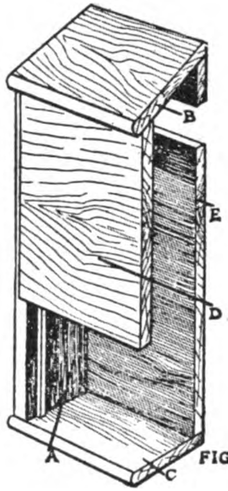


FIG. 2.

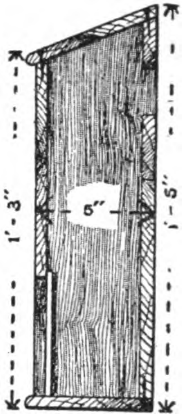


FIG. 3.

and back of the box, after which the sides, top and bottom may be finally fixed together. The overhanging front and end edges of the top and bottom should be rounded, as shown in the illustrations, and the joints when finally fixed together should be secured with glue.

The front of the box *D* is then prepared and fixed in position, an opening 5 in. high being provided for the door. The front simply fits into the grooves prepared for its reception in the front edges of the sides, and is fixed in position with nails, as shown in Fig. 5. The back of the box *E* must next receive attention, and it is fitted and fixed in a similar manner to the front. A slit must be provided in the back of the box, and it should come exactly behind and corre-

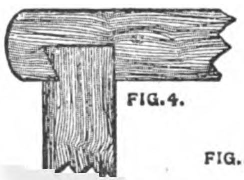


FIG. 4.

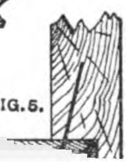
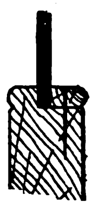


FIG. 5.



spond with the slit in the street door. If the slit is made in the horizontal door rail it should be cut in a horizontal position, but if it is in the middle vertical rail it should be in a vertical position, and a convenient size would be about 5 in. long by 1½ in. wide.

The small door which is fitted at the bottom of the box is framed together, and fitted with a glass panel. The framework should be 1⅛ in. wide by ½ in. thick. A rebate, 5/16 in. wide and ⅛ in. deep, is cut in the back edge of the framework, and the front edge is beaded, as shown in Fig. 6. The framework is put together with mortise and tenon joints, similar to that shown in Fig. 7, and the joints are finally fixed with glue. The door should be hung to the box, on the right-hand side, with a pair of 1 in. butt hinges, and a small lock or suitable fastener should also be fitted to the door.

Two small wood fillet pieces are fixed on the inside of the box, directly behind the door, to act as stops, as shown in Figs. 2 and 3. The glass panel, which is fitted to the door, should then be cut to fit in the rebates in the framework, and it is fixed in position with small fillet pieces, as shown in Fig. 6.

The box may now be finally cleaned off, and the exterior should be either stained and varnished, or painted. The box is fixed to the door with two metal plates, similar to that shown in Fig. 8. The plates are first fixed to the back of the box with screws, and the box is then finally fixed to the door with screws, which are driven through the holes in the ends of the plates.—*Hobbies.*

HINTS FOR CARPENTERS

Little Things for the Woodworker to Note and Remember

Every woodworker discovers little short cuts in his work which materially help him to attain rapidity and perfection, says the *Blacksmith and Wheelwright.*

In measuring with a rule, tip it on edge so that the dimension marks are adjacent to the piece being laid out, and in taking a series of dimensions start from one point only.

Always tip a plane on its side when laying it on the bench so as not to dull the iron. For the same reason always raise the plane from the work on the return stroke.

In planing end grain never run the plane entirely across the end, but work from both edges toward the center of the piece. This prevents the splitting of corners.

In using an oil stone there are three things to observe: (*a*) Use plenty of good oil; (*b*) Clean the stone well before putting it away; (*c*) Use the entire face of the stone, not merely the center. If the hole from the other side after the worm penetrates.

Do not drive a screw into a board with a hammer, as its holding qualities will be greatly lessened.

Always drive nails and brads at an angle, as they will then hold more securely.

In sandpapering always use a block if possible, as this will prevent rounding edges where they are not wanted.

Sandpaper should be used for cleaning and smoothing purposes only. Do not depend upon it for doing the tool work.

Sandpapering should not be done across grain.—*American Carpenter and Builder.*

In the Carpenter Shop

"Life's a hard grind," said the emery-wheel.

"It's a perfect bore," returned the auger.

"It means nothing but hard knocks for me," sighed the nail.

"You haven't as much to go through as I have," put in the saw.

COMPARATIVE FUEL VALUES OF GASOLINE AND DENATURED ALCOHOL IN INTERNAL-COMBUSTION ENGINES

R. M. Strong and Lauson Stone, the authors of the bulletin just issued by the United States Bureau of Mines, say in their introduction: "Under the terms of the act establishing the Bureau of Mines, this bureau was authorized to carry on the work of testing and analyzing fuels which work had been previously conducted by the technologic branch of the United States Geological Survey. That work included in its scope an investigation of the availability and uses of liquid as well as solid fuels, for the original outline of the fuel-testing investigations contemplated, a study of the liquid-fuel resources of the country and the making of related researches to determine how these resources could be utilized with greatest efficiency.

"Owing to the fact that many difficulties were being encountered in the adaptation of the heavier fuel oils for convenient use in internal-combustion engines, it was deemed best to begin the investigation of liquid fuels with tests of gasoline, a fuel in more or less general use.

"When this investigation began, the extensive introduction, especially by foreign powers, of liquid fuels for small naval craft had awakened much interest. However, the quality of gasoline was reported to vary materially in different countries and the quantity available was said to be rapidly decreasing, with the probability of a prohibitive increase in price. At the same time the claim was made that denatured alcohol, of fairly uniform quality, could be procured in all parts of the world, that unlimited quantities could be readily produced at a low cost, and that this fuel could be used much more efficiently than gasoline in internal-combustion engines. Such statements naturally led to a widespread belief that the time was near at hand when denatured alcohol would entirely displace gasoline as engine fuel. Therefore, the first investigations of the liquid mineral fuels logically embraced a careful series of comparative tests of gasoline and denatured alcohol in engines. A series of over 2,000 such tests was conducted at the Government fuel-testing plants at St. Louis, Mo., and Norfolk, Va.

HEATING VALUE

"The low heating value of completely denatured alcohol averages 10,500 British thermal units per pound, or 71,900 British thermal units per gallon.

"The low heating value of gasoline having a specific gravity of 0.71 to 0.73 averages 19,200 British thermal units per pound, or 115,800 British thermal units per gallon.

"The low heating value of 1 lb. of alcohol is approximately six-tenths of the low heating value of 1 lb. of gasoline.

"One pound of gasoline requires approximately twice the weight of air for complete combustion that is required by 1 lb. of alcohol.

"The heating value of 1 cu. ft. of an explosive mixture of alcohol vapor and air having theoretically just sufficient air for complete combustion is approximately equal to that of 1 cu. ft. of a similar explosive mixture of gasoline vapor and air—about 80 British thermal units per cubic foot.

"Explosive mixtures of alcohol vapor and air in an engine cylinder can be compressed to much higher pressures, without pre-igniting, than explosive mixtures of gasoline vapor and air. The maximum compression that can be used in an engine without causing preignition depends on the quality of the explosive mixture, the design of the engine, and the speed at which it is operated.

"For 10 to 15 h.p. 4-cycle stationary engines of the usual type, a pressure of about 70 lbs. per square inch above atmospheric pressure was found to be the maximum that could be used for gasoline mixtures, and about 180 lbs. the maximum that could be used for alcohol mixtures, without causing preignition.

"The maximum compression that could be used without causing preignition was in each case found to be the most advantageous with regard to fuel economy.

"When the degree of compression in each engine is that best suited to the economical use of the fuel designated, some type of gasoline engines are better adapted to the service for which they are designed than similar alcohol engines,

and *vice versa*. This is also true (the relative quantity of fuel consumed being disregarded) when the degree of compression is that ordinarily used for gasoline mixtures, as when denatured alcohol is used in gasoline engines. But, in general, the alcohol engine is or can be so designed and constructed as to be equal to the gasoline engine in adaptability to service.

"A gasoline engine having a compression pressure of 70 lbs., but otherwise as well suited to the economical use of denatured alcohol as gasoline, will, when using alcohol, have an available horsepower about 10 per cent. greater than when using gasoline."

Copies of the bulletin may be obtained by addressing the Director of the Bureau of Mines, Washington, D.C.

TUNGSTEN AND ITS USES

An Unusual and Important Mineral Widely Employed in Various Industries

Last year there was a sharp decrease in the production of tungsten ore owing to the decrease in the demand for tool steels, in which the bulk of the tungsten produced is used, according to Frank L. Hess, in a report on this metal just issued by the United States Geological Survey. The production of domestic tungsten ore in 1911 amounted to 1,139 short tons of concentrates, carrying 60 per cent. of tungsten trioxide, valued at $407,985; in 1910, the production amounted to 1,821 short tons, valued at $832,992.

Tungsten is used chiefly in making steels that will hold their temper when heated, but it is most generally known as supplying the filament of tungsten incandescent lamps. The great improvements in drawing tungsten wire and further notable improvements in the size of the globe of the tungsten lamp and in other mechanical details that add greatly to its efficiency are making it encroach upon the carbon-filament lamp and the arc lamp, and it is rapidly driving from the market the tantalum lamp, which was the first good incandescent lamp having a metallic filament. Diamonds are used for dies in drawing tungsten wire. At first it did not seem possible to drill small enough holes through the diamonds to make wire sufficiently fine for lamps of small candlepower, but wire 0.0006 in. in diameter can now be drawn in quantity. The total quantity

jectile is made of lead with a jacket of copper-nickel alloy. The principal advantage of lead over iron, which would of course be cheaper, is that it has a higher specific gravity. Because of this fact a lead bullet will have a smaller cross section and will therefore encounter less air resistance to its flight than will an iron bullet of the same weight, and it will consequently give a flatter trajectory and longer range. An iron bullet of the same diameter as the lead bullet could of course be made of the same weight by increasing its length, but this would at once necessitate giving it a higher rotational velocity to keep its axis tangential to its flight. To impart this added rotational velocity would call for the expenditure of energy and so leave less for velocity of translation. With the exception of tungsten, lead is the densest metal which can be considered for this purpose, for gold is the cheapest of the other elements having a higher specific gravity than lead.

For military purposes the softness of lead is not an advantage, a soft-nosed bullet being tabooed in civilized warfare. For this reason and because of the fact that it is too weak to hold the rifling, it has to be jacketed with copper-nickel alloy. To take the rifling and to act as a gas check, the tungsten bullet will require a copper band

PROGRESS IN DIRECTIVE WIRELESS TELEGRAPHY

A paper by Mr. F. Addey, on "Directive Wireless Telegraphy," was read before the British Institution of Post Office Electrical Engineers. He pointed out that at an ordinary wireless telegraph station the signals were radiated equally in all directions, and that, of course, for many purposes this was advantageous. In certain circumstances it was very desirable, however, to be able to restrict the signals sent out from a station to a definite line, and to receive signals only when they came from a definite direction. For instance, by directing the emitted waves in this manner, interference with stations lying off the line was avoided and energy was saved which would otherwise be wasted. At a receiving station a directive arrangement greatly reduced trouble due to interference from other stations and from atmospheric discharges.

After describing the directive arrangements devised by Brown, Marconi, Bellini, and Tosi, the Telefunken directive aerial, and the directive experiments of Kiebitz, the author discussed the various uses to which these arrangements had been applied in practice. He pointed out that the simplest use of a directive aerial was to increase the range of a station in a certain direction. The large transatlantic Marconi stations were provided with directive inverted L aerials, because they always worked in the same direction. A most important application of directive systems was to enable ships to obtain the bearings of wireless stations on shore. When a ship was navigating within sight of shore her exact position was ascertained by the process known as "cross-bearings," and Marconi, in 1906, patented an arrangement for attaining this end. A number of inverted L aerials radiating at equal angular distances from a point were erected on the shore. By means of a switch the receiving apparatus could be joined to any one of these aerials. vantages in such a method, and Bellini and Tosi had devised a very ingenious arrangement by which a resultant aerial could be rotated while the actual aerial system remained fixed.

The French Government had fitted a large wireless station at Boulogne with the Bellini-Tosi apparatus. The aerials, each consisting of six wires, were attached to the triatic stays between the four towers employed, and were brought outwards so as to make an angle of about 30 degrees with the vertical. The station was arranged for working with a 300-metre wave, and therefore, the length of the base of each compound aerial was about half this distance. Actually the length of the base was 388 ft., or 127 metres. Non-directive apparatus was provided at the Boulogne station in addition to the directive, and the station "stands by" on that arrangement so as to be able to receive from any direction. When a ship wished to find her bearings the directive was substituted for the non-directive apparatus, and the direction from which the ship's signals were received was observed. This information was then communicated to the ship. By this system it was possible to obtain bearings correctly to within two or three degrees.

In the methods described the observation of direction was made at the shore station, and the result communicated to the ship. It would obviously be better if the ship could observe the direction of the shore station, and methods by which this could be done had been devised. The shore station might have a number of radiating aerials from which signals were successively emitted, and the ship might be provided with means by which the signals from each of the aerials, the directions of which were known, could be distinguished. Then by observing the strengths of the signals received from the

developed by the Telefunken Company. The second method by which the ship could obtain her bearings without the coöperation of an operator on shore, that, namely, in which the ship was fitted with a directive installation to ascertain the direction of a non-directive installation on the shore, had been developed by the Marconi Company, and was known as the Marconi wireless compass. In this system a modification of the Bellini-Tosi system was used, the opposite halves of each directive aerial being joined together at the top. In an actual installation fitted for experimental purposes on board the *Onward*, one of the Cross-Channel boats of the Southeastern & Chatham Railway, the widths of the bases of the triangular aerials were only 42 ft. and their height only 40 ft. The ordinary aerial and wireless installation were not altered in any way when the compass system was fitted, and were used for the wireless business of the ship as before.

With the Marconi wireless compass bearings could be taken to within two degrees. The reduction in the size of the aerials from the dimensions originally used by Bellini and Tosi had not made the arrangement very insensitive, and, indeed, on board the *Onward*, using a 600-metre wave, signals were occasionally received from ships in the Mediterranean while the *Onward* was making her passages between Boulogne and Folkestone.

The utility of these methods of taking bearings to ships depended on sufficient wireless stations being built on the coasts to give the necessary coöperation. With the systems in which the bearings were actually measured on the ship, it was evidently desirable that the shore stations should be continuously in operation, and this necessitated the provision of some form of automatic transmitting gear. The French Government had taken up this question, and after experiments with two stations near Brest had decided to install wireless lighthouses or "radiophares" round the whole French coast. These stations were being fitted by the Société Française Radio-Electrique. In order to prevent interference between these continuously working radiophares and adjacent commercial stations, the recent Wireless Telegraph Conference in London had decided that they should be so fitted as not to have a range greater than 30 nautical miles and a wave-length not exceeding 150 metres.

Aviation Fatalities Analyzed

If the past year has done nothing else, it has demonstrated most conclusively that there can be no general use of aeroplanes except for war purposes until the question of safety has been solved. This is a matter which is now beyond argument. It may be true that Americans, as a result of carelessness, reckless show stunts, and the use of poor constructions have suffered far more than their due proportion of deaths, but this does not alter the basic fact that flying a machine is still a matter of balancing in the air, more or less of an acrobatic feat, and if once the equilibrium is lost, disaster is sure to come in the ensuing fall.

For 1912 the number of aviation deaths has increased from 82 in 1911 to 116. The proportion of deaths to aviators, or to distance flown, is probably no greater than in the preceding twelve months, but the difficulty lies in the treachery of the air. It may reach out and take the best, while a reckless fool escapes with a few bruises.

Americans take an unenviable prominence in the table of fatalities for 1912. Up to date there have been twenty-seven killed in this country this year, with not many more than one hundred aviators flying. France with four or five times this number in active operation has been the scene of only twenty-eight fatalities, just equaling the German record, where the military pilots alone number two hundred. England with more than double the total pilots in the United States has lost sixteen in the past twelve months; Italy, five; Russia, four, including Popoff, killed with the Bulgarian forces, and the remainder have been scattered through the smaller nations.

In 1911, France had a total of twenty-eight fatalities, just equaling those of the present year, but the added number flying makes the 1912 record by far the better. America stood second in 1911 with sixteen; Germany third, with fourteen, and then came England with five, Austria and Russia with four each, Japan, two, the rest being widely scattered.

QUESTIONS AND ANSWERS

Questions on electrical and mechanical subjects of general interest will be answered, as far as possible, in this department, free of charge. The writer must give his name and address, and the answer will be published under his initials and town; but, if he so requests, anything which may identify him will be withheld. **Questions must be written only on one side of the sheet, on a sheet of paper separate from all other contents of the letter, and only three questions may be sent at one time.** No attention will be given to questions which do not follow these rules.

Owing to the large number of questions received, it is rarely that a reply can be given in the first issue after receipt. Questions for which a speedy reply is desired will be answered by mail if fifty cents is enclosed. This amount is not to be considered as payment for reply, but is simply to cover clerical expenses, postage and cost of letter writing. As the time required to get a question satisfactorily answered varies, we cannot guarantee to answer within a definite time.

If a question entails an inordinate amount of research or calculation, a special charge of one dollar or more will be made, depending on the amount of labor required. Readers will, in every case, be notified if such a charge must be made, and the work will not be done unless desired and paid for.

1918. **Electromagnet Design.** F. M. Y., West Brooklyn, Ill., asks: Will you give me a design for an electromagnet that with a voltage of 1½ volts and current of 1 ampere or under will support about 250 lbs.? It is proposed to use one cell of dry battery of common telephone size, and the total weight of magnet and battery is to be under 10 lbs. Ans.—You are asking too much, as the space in this department is too limited for a lengthy reply. We would advise you to consult Chas. R. Underhill's book, "Electro-Magnets and Electrŏ Windings," which we can supply for $2.00.

1919. **Voltage Regulation.** J. B., Bridgeport, Wash., says: (1) I have thought out a device which will automatically regulate the voltage on a lighting or power system. It is in the form of two plungers working inside of two wire-wound magnets and an arm is attached to a sliding bar, on the current regulator. I want to know whether it is on the market or in use. (2) Cannot the telephone be arranged to ring the bell from the battery instead of using a generator to ring the bell, and have the bell ring by a push button contact in the battery circuit? Ans.—(1) In the absence of more detailed information, it is impossible to say whether or not your device infringes upon the patents of some of those already upon the market, but there is one whose operation is similar. (2) It would be necessary to replace the high resistance ringers of the magneto telephone with coils whose resistance would not exceed 5 ohms, and the bell would have to be of the vibrating type. Its operation probably would not be very satisfactory over a long line.

1920. **Storage Battery.** W. S. H., Carleton Place, Ont., says: An amateur here wishes me to write you thus: He has made the accumulator as per your directions in April, 1911, by Wm. C. Houghton, and has failed, *i.e.*, neither the oxide of lead nor the litharge will harden. He is under the impression that it will all chip or fall off when put to work. Please say what shall he mix in with the paste to make it hard? Reply fully. Also how [illegible]

at that. After the grids are pasted let them dry for a day, then plunge them for the shortest possible instant in a suitable quantity of the weak solution, and let them dry for another day. If you hold them in the solution too long, the renewal of chemical action will evolve gas and the filling will be pushed out. Keep up this treatment for such a succession of days as will permit the immersion without visible chemical action. Then when the plates are finally assembled and placed in the electrolyte, no untoward action should be experienced. However, no delay must be permitted in getting the charging current into operation. If you have only a single cell, the full rate charging from a 110-volt circuit with lamps used for resistance will be very uneconomical. You can charge at a very slow rate, letting the current be that ordinarily flowing through some one or two lamps that are most used, say in some corridor. The theft of 2.5 volts might not be serious. You will find Watson's book on Storage Batteries will help you in a good many particulars.

1921. **Dynamo Construction.** A. J. A., Lithonia, Ga., says: Please find enclosed a drawing of a D.C. dynamo, and write me if the proportions are good for a machine that will generate 35 volts and 6 amperes at a reasonably low speed. If they are good, tell me what size wire for field and armature, and how many turns. The armature is 4½ in. in diameter and 3 in. long, and has 20 ½ in. round holes. The field cores are 2½ in. cross section and 3½ in. long, winding space 3 in.; coils to be form wound; field poles are of cast steel and field ring is 3 x ½ in., of wrought steel. Ans.—Unless you are counting on a very slow speed, the machine proposed is much larger than required—indeed, even at such a reasonable speed as 1,500 revolutions per minute the output could approach 1 k.w. 6 amperes at 35 volts means less than ¼ k.w., and Watson's machine of that output is as good a design as you can find. If you prefer a machine having an armature of the size you have shown, the proportions of the field [illegible] Your

at least 4 sq. in. of section, say ¾ x [illegible] but if of cast iron, ⅞ x 5 in. With these new considerations in view, if you will make a new sketch, we will be pleased to compute suitable windings.

1922. **Dynamo Construction.** G. D. M., Bridgeport, Conn., says: I built a dynamo a while ago, and it was supposed to be 2 k.w., but could never get very much out of it. I wanted to get 110 volts, 15 to 20 amperes A.C. single-phase 160 cycles run at 3,000 revolutions per minute. It is a six-pole machine with laminated field pole cast in an iron ring. Fields are wound with No. 24 enameled wire requiring about 6 lbs. Have had anywhere from 1 to 150 volts D.C. for exciting current, but they never heated up at all under any conditions. The armature is of the single coil as per pole type, that is, it has 6 slots. It was wound with No. 19 d.c.c. magnet wire, 180 turns per slot, 1,080 total number of turns. It gave about 300 volts, 3 amperes, so rewound with No. 14 d.c.c. magnet wire but only got 40 volts 12 amperes. It seemed to be heavily loaded with one lamp (60 watts) and a voltmeter and armature heated up so bad that you couldn't touch it. So I thought the winding was wrong and went ahead and made another armature having 36 slots wound with No. 19 enameled wire, 60 turns per slot, 2,160 total number of turns, but gave only 20 volts 12 amperes. The belt slipped so much that I lost the speed of armature and the armature heated up worse than the other one. The 36-slot armature was wound with a regular D.C. winding connecting outside one coil to the inside of the next coil. The first coil was started in slot No. 1 and ended in slot No. 7, skipping 6 slots for every coil. Six leads were brought out, 3 to each collector ring. One collector ring having leads from coils 1–13–25, the other ring leads from coils 7–19–31. Both armatures have been tested in every way I could think of, and I can say that they are free from any short circuits or grounds. I also tested fields for the right polarity alternate north taken south, and they are O.K. tested with battery and galvanometer. This design of this machine was copied from a book entitled "Designs of Small Dynamos and Motors," by Cecil Poole. A couple of the field poles are out about 3-32 in. and in a D.C. dynamo it would cause sparking at the brushes, but shouldn't think it would kill it altogether. I enclose blueprint of field casting, also data on armature. Please look into it as far as possible. Let me know in what way I may cure the troubles. Tell me what the charges will be, and I will be ready to proceed if I send a reply to that effect. Ans.—We are very glad you sent the fine blueprint of the field magnet. In general we would advise you not to imitate the in slots 2 and 5, using No. 16 d.c.c. wire, 3 wide and 7 deep, 21 turns in the coil. Without cutting the wire, continue in the same direction but in slots 1 and 5. Slots 3 and 4 will be surrounded but will have no wire at all in them. Cut the wire, and in slots 8 and 11, 7 and 12 wind similar coils, and in the same direction. Similarly, in slots 14–17, 13–18; 20–23, 19–24; 26–29, 25–30; finally, 32–35 and 31–36. Thus, only 24 out of the total 36 slots will be utilized. This appears to be a defect, but is merely a recognition of the fact that a single-phase armature has only about two-thirds of the output of a three-phase machine of the same size. With the six groups of coils thus formed, join together the inside ends, or beginnings, of groups 1 and 2, then the two outside ends of groups 2 and 3, the inside ends of 3 and 4, the outside ends of 5 and 6, finally leading the outside ends of groups 1 and 6 to the collector rings. You will recognize that the connections follow exactly the same rule as for the six field coils. You can adopt the same procedure for the 6-slot armature, winding a coil around one tooth, but occupying only half the room in the slots, thereby leaving room for the coil that embraces the next tooth. You will find explicit directions for making a machine of just this sort in Watson's "How to make a 1,000-Watt Alternator." Your machine seems to be over-rated, for the most we can figure for it is 1 k.w. Watson's machine is larger, but rated at only 1 k.w., but at a lower frequency. Please let us know the results of following these directions.

1923. **Incandescent Lamp Manufacture.** C. C. B., Rochester, N.Y., asks: (1) Can you give me the procedure for obtaining a chemical vacuum after obtaining the best mechanical vacuum? (2) Why does the bulb of a small Tungsten lamp become blue when first lighted? It seems only to effect those in which the filament is close to the glass. (3) By what process are the small loops of the Tungsten filament formed? Ans.—(1) In the manufacture of carbon filament incandescent lamps, a small amount of red phosphorus is introduced into the neck of the tube through which the exhaustion is to be made. The mechanical vacuum pump removes almost all of the air, then current is turned through the filament, the heat expelling the air that was occulted in the mass of carbon. Also, when the temperature is sufficiently high, the phosphorus is ignited, the combustion being effected at the expense of the remaining traces of oxygen. At first the bulb is filled with bluish light, indicating a poor vacuum, but after the chemical combination of the phosphorus and the oxygen, the light becomes a clear white. The skilled operator closely watches for this transition in brilliancy. (2) Blueness is usually

to make a dynamo and motor combined to use for starting a gasoline auto. As a motor it would need to be about ¼ h.p. or over. What size wire on armature and fields should I use; how many feet of wire; and how many divisions on commutator should I make? It is to be run on a 6-volt 20-ampere current of dry cells. Ans.—Your estimates are a little incorrect. If ¼ of a horse-power is required—almost 200 watts of effective energy—you cannot get this from a circuit involving 6 volts 20 amperes, which means only 120 watts. Further, the motor would have considerable losses, and you might have to put in 300 watts or more of electrical energy in order to get the desired ¼ h.p. Dry batteries are quite inadequate for the supply of current. The rating you have given means 6 volts on open circuit—when no current is flowing—and 20 amperes on short circuit—when the available voltage is zero. The effective condition is when a useful external circuit is connected, as, for illustration, the motor you desire to run. There might be a reasonably large current at the instant of closing the switch, but if the motor started, it would at once set up a counter electromotive force, which would reduce the current. About 1 volt and 3 amperes is all a dry cell can produce for useful effect.

1925. **Inductive Tuner.** W. H. W., Asbury Park, N.J., asks: Can you give me specifications for building an inductive tuner that will be capable of tuning to a wave such as is used by the Glace Bay, Clifden and new Arlington stations? This tuner to be used with an aerial 75 ft. in length, six-strand. Ans.—Your natural period is about 100 meters. With so small an antenna you will find it difficult to hear these stations unless you have a large tuning coil. The wave-length of Glace Bay is 6,000 meters, and Arlington about 3,800. The following is the method used by some commercial stations, and is very good, also simple. Build three coils, each 3 in. in diameter and long enough to wind 180 turns of No. 22 wire. Use No. 2 and No. 3 as the primary and secondary of an inductive tuner. Have them very close, and do not vary the coupling. Use No. 1 as a loading coil. When you wish to get long wave, have a switch to connect the dead end of No. 1 to the slider of No. 2 and a switch to throw the antenna from No. 2 to the slider of No. 1; have a ground at one end of No. 1 and No. 2. No. 3 will act as the secondary, and have the usual instruments in this closed circuit. Best results will be obtained if you have a variable condenser across the secondary.

1926. ½ **K.W. Transformer.** G. W. H., Tacoma, Wash., says: (1) Would like to know if core as shown in drawing is large enough to make a ½ k.w. transformer. If so, how much and what size wire should I use to wind primary and secondary coil to be used for wireless work? (2) What size condenser to be used with ½ k.w. transformer? Ans.—(1) The size iron you suggest would be very unsatisfactory for a transformer of this type. The August and September, 1912, issues of the *Electrician and Mechanic*, which can be furnished for 15 cents each, contain data for ½ k.w. transformers for wireless work. (2) Normally about .004 mf. is used, but with the requirement of a 200-meter wave-length it is impossible to use much over .001 mf. See the article by H. B. Richmond on this subject, in the December, 1912, *Electrician and Mechanic*.

1927. **Transformer.** C. E. P., Long Island City, N.Y., says: I have built a coil or transformer as follows: Core 1⅛ x 10 in., of No. 22 core wire; two layers empire cloth, and two layers friction tape around it; primary three layers of No. 12 D.C.C. wound in shellac and dried; insulation 1-32d micanite tube, three layers empire cloth, two layers of friction tape and cardboard tube about 1-16 in. thick. Secondary, 4½ lbs. No. 30 s.c.c. in 16 sections ¼ in. thick, those at the ends of coil being 4 in. in diameter, and in center 4½ in. Before assembling, the core and primary, and each section, were thoroughly cooked in parowax in a double boiler, allowed to cool off in wax, then carefully trimmed and scraped to size. Secondary placed in position cold, with four sheets waxed fiber between sections, and the coil again thoroughly cooked in parowax, allowed to cool in wax, then set in case, and melted wax poured in to fill the case, which was then set in oven until wax softened enough to fill all corners, after which it was cooled, and melted wax added to replace shrinkage on top. Please advise: (1) Probable efficiency and power rating of this coil as an open-core wireless transformer, and current required to operate it on 110-volt 60-cycle current. (2) What will I need as resistance or reactance in connection with it? (3) Size of secondary condenser (8 x 10 glass plates cast in parowax)? Ans.—(1) It is impossible to even approximate the efficiency of coils unless considerable work has been done on similar coils. The only way to find out is to test the coil. Unless it is very important that the efficiency be known, it is seldom worth while to find out. It would not be surprising if the coil required 150 watts on full load. (2) Use about 750 ft. of No. 8, 30 per cent. alloy German silver wire wound on asbestos-covered cores. If a reactance coil is to be constructed, make the core 1½ x 1½ in. and 8 in. long. Wind with 4 lbs. of No. 14 d.c.c. wire. After the first hundred turns, bring out taps every 25 turns. You will then have an impedance coil such as will prove valuable in experimenting. (3) From 6 to 10 pairs of elements will be required.

1928. **Inductance Coil.** J. C. W., Topeka, Kans., asks: (1) What should be the dimensions of an inductance coil for the wavemeter described in the September number of *Electrician and Mechanic*, to be used with wave-lengths under 200 meters? (2) How should the curve be plotted for this coil? (3) May a rotary condenser of different dimensions, but having the same capacity, be used? Ans.—(1) Use the same size wire and form as was used in the other coils, but reduce the number of turns to six. (2) To plot a curve for a coil it is necessary to have a standard wavemeter. By means of the standard wavemeter some oscillatory circuit is adjusted to a known wave-length, then the scale reading for the meter under consideration is noted. By using the scale reading for an abscissa and the known wave-length for an ordinate, one point of the curve is determined. By repeating this process it is possible to obtain sufficient points to determine the curve. (3) Yes.

1929. **Dynamo.** G. C., Upper Sandusky,

Ohio, wishes to rewind a small dynamo that has a single coil field magnet, a 12-slot armature and a 6-segment commutator. If No. 22 wire is used on field magnet, what size should be put on armature? Ans.—In the absence of any actual dimensions of the machine, our answer can but be guesswork. The machine should work if you put No. 18 on armature, and connect the field as a shunt, or use No. 26 on armature and connect the field winding in series. For general experimental purpose the shunt connection is more useful. The commutator would be better if it had 12 segments rather than 6. You should have sent a carefully drawn sketch of the field magnet and armature core, specified the dimensions, the output desired, and the speed. Then we could have advised you much more definitely.

1930. **Medical Coil.** H. T., Brooklyn, N.Y., asks: Please give me directions for making a medical coil with four connecting or binding posts, two high and two low. Ans.—In the absence of explicit statements of just what output you want, we will suggest a simple construction for a small and inexpensive coil that will certainly be useful for many experiments or treatments. Of course we expect that you have access to use of suitable working tools. Find a stick of hard wood about 1½ in. square and 6 in. or 7 in. long. Bore a ½ in. hole lengthwise. Mount stick on an arbor and turn it to about 1⅛ in. in diameter. Leaving the ends at this size for ⅜ in. or more, turn the portion between to a diameter of ⅝ in. Similarly make four short wooden spools, 1¼ in. inside diameter, 2½ in. outside diameter, and 1½ in. long, flanges being about ⅛ in. or 3-16 in. thick. Soak all five in melted paraffin, and when dry, wind the long spool with four layers of No. 18 d.c.c. wire, and the small ones with No. 36 s.c.c. wire. Ends of the coarse wire may be led directly through the heads of the spool, but for the fine wires, slanting holes will be best, so the ends leading to the bottom will be left at the outer edge rather than near the center. To minimize danger of breaking off this inner end it is well to double or triple the wire and twist it in a sort of cable. Again soak the wound spools in melted paraffin for a few minutes. Wind several layers of tough paper around the long spool until a thickness is secured to make the other spools a snug fit. Slip those four in place, and connect inside end of one coil to outside of other, so as to give the effect of a continuous winding, and connect these junctions to a row of binding posts. Counting in the extremes there will be five posts in all for this secondary portion of the winding. The primary will have two more. Obtain some tinsmiths' annealed iron wire for the magnet core. This can be finely straightened by forcible stretching

or less of the secondary coils, a variation of voltage may be secured, and by connecting to the two parts that carry the platinum contacts, an interrupted primary effect may also be obtained.

1931. **Electric Pocket Book.** J. Y., Jr., Floreffe, Pa., says: Please let me know which is the best electric pocket book for the troubles of motors, how to repair them and how to run them slow or fast; also the price. Ans.—Perhaps the book published by the Cleveland Armature Works, or Crocker's book on Dynamo and Motor Troubles will suit. The latter can be furnished by us for $1.00.

1932. **Inductance.** T. C., Newport, R.I., asks: (1) What is the formula for finding the inductance (in centimeters) of a tuning coil? (2) At what time of night does Glace Bay, C.B., send out long distance press news? (3) The formula for the wave-length of a station contains the expression, $\sqrt{LC}$. In order to keep this a constant, an increase of one value would, of course, require a decrease of the other, yet if I increase the inductance in the secondary of my loose-coupler, it requires an increase of capacity to bring a station in tune again. The loose-coupler is one of Clapp-Eastham's old type—not a Blitzen. What causes this apparent impossibility? Ans.—(1) The February, 1911, *Electrician and Mechanic* contained an article on this subject, by Mr. E. C. Crocker. (2) We have heard them going about every hour of the night from early evening until morning. They send commercial messages for the most part. (3) There is a possibility that you are tuning to an overtone, that is, some wave-length such as twice the original. Are you sure that your condenser scale does not read degrees "out" instead of degrees "in," so that you are really decreasing your capacity instead of increasing it?

1933. **Wireless Station.** E. A. F., Sound Beach, Conn., asks: (1) Can a windmill tower be used to advantage as an antenna for a wireless station? (2) If not, could it be used for a support for such an antenna? (3) If it can be used to advantage in either of the above ways, would it be advisable to set the foundation in concrete as a sort of insulation? Ans.—(1) No, because of the absorptive and magnetic powers of iron. (2) Yes, for small power amateur stations it would serve very well. (3) It would be best to set it in concrete, but for amateur work it would hardly be worth the expense.

1934. **Auto Transformer.** H. A. V., Rochelle, Ill., says: I notice in your December issue, under "The Construction of an Auto Transformer," that you state that the supply current of 110 volts should enter at *A* and *J*. Is that correct? If so, what function do the ends *X* and *Y* do? Am constructing one of these coils but this item rather puzzles me. Ans.

BOOK REVIEWS

Motion-Picture Work. A General Treatise on Picture Taking, Picture Making, Photo-Plays and Theatre Management and Operations. By David S. Hulfish. Illustrated. Chicago, American School of Correspondence, 1913. Price, $4.00.

The field of motion-picture work is now so wide, and the industry has attained such commanding importance in the economic life of the United States, that a thorough compilation of our knowledge on the subject is not only desirable but fills a great want in technical information. This imposing volume, containing many hundred pages, the number being difficult to estimate because the illustrations are not included, is a comprehensive treatise which covers the whole subject in all its branches. Beginning with the simple optical lantern, it explains the principles of projection of lantern slides of the simple and the dissolving lantern with gratifying thoroughness. From this the transmission to the moving-picture machine is easy, and the motion head in all its parts is described. The various makes of moving-picture machines on the American market are then gone into in full detail. The second part of the book describes the making of motion-picture films, both photographically and as regards the construction of the equipment. The management of a moving-picture theatre is fully described, and finally the electrical principles involved are considered at length. There seems to be no department of the work which is not adequately treated, and we cordially commend the book as a thorough-going helper to anyone interested in the subject.

Popular Mechanics Shop Notes for 1913, Vol. IX. Popular Mechanics, Chicago, Price, 50 cents.

The title on the outside cover of this useful book is "Popular Mechanics Year Book," but it continues the series of shop notes which have proved so useful in the last nine years. It consists, as previously, of pages reprinted from "Popular Mechanics," and contains an enormous variety of useful hints on every kind of mechanical work. Anyone interested in mechanics of any kind will find many articles of value to him in this compilation.

Saw Filing and Management of Saws. By Robert Grimshaw, M.E. New York, The Norman W. Henley Pub. Co., 1912. Price, $1.00. A Practical Treatise on Filing, Gumming, Swaging, Hammering and Brazing Band Saws. Speed, Power and Work to Operate Circular Saws, etc. With Full Directions for Filing, Setting, Polishing, Joining, Straightening and Polishing Hand, Butchers, Band and Circular Saws. Files to Use, Useful Hints for Repairing and Caring for Saws. Coiling and Brazing Hand Saws, Home-made Sets [illegible]

Manual Training Toys for the Boy's Workshop. By Harris W. Moore, Supervisor of Manual Training, Watertown, Mass. The Manual Arts Press, Peoria, Ill. Price, $1.00.

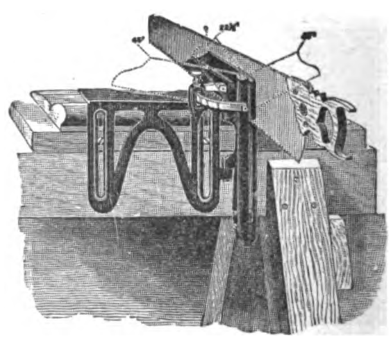
This book, while written for young manual training students, describes the making of many things which will appeal to older tool users, such as the ever popular "Happy Jack" windmills, and other interesting things, which will find ready sale, as well as prove interesting at home. The bulk of the toys described, however, are for the use of school boys, and the directions and work involved are well within their abilities. The choice of subjects is excellent and the treatment is thorough-going.

We acknowledge receipt from D. Van Nostrand Co., of a catalog of books on Electricity, classified by subjects, being Part II of their Catalog of Scientific Books. It will be sent to any interested reader on request addressed to D. Van Nostrand Co., 25 Park Place, New York.

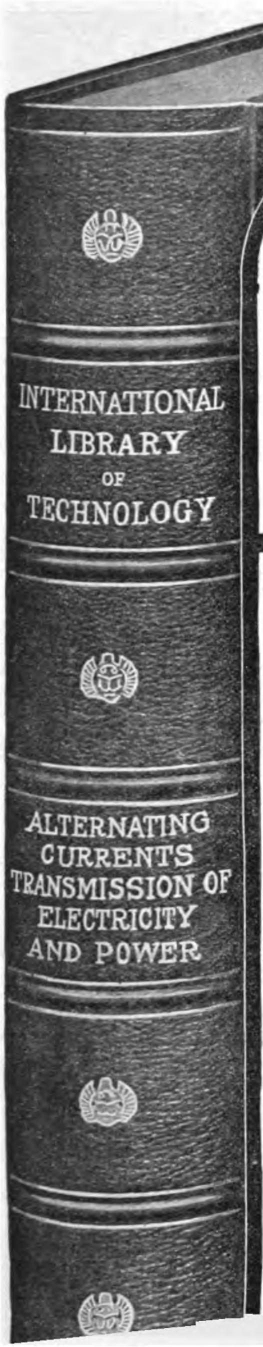
TRADE NOTES

Our readers no doubt will be interested in a practical mitre box that weighs but 2 lbs., and that can be folded and carried in any ordinary tool chest. For cutting mitres in conduit or molding, it has no equal.

We refer to the "RED DEVIL" Mitre Box shown herewith. It is manufactured by the Smith & Hemenway Co., 150–152 Chambers St., New York, who also manufacture over 3,000 various styles of tools for carpenters, electricians and mechanics generally.



The "RED DEVIL" Mitre Box is all metal. It is light (2 lbs.) and is self-contained, that is, it is all complete, and has no extra parts to become misplaced or lost. It is so constructed that any width, depth or length of mitre can be cut, and any saw can be used. No special mitering saw is required. The mitering gauge is so simple that a child can use it. All that is re- [illegible] gauge at any angle [illegible] The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TECHNOLOGY
ALTERNATING
CURRENTS
TRANSMISSION OF
ELECTRICITY
AND POWER

TRADE NOTES

The new wireless laws applying to license and traffic regulation serve to emphasize more strongly if possible, the importance and responsibility of the wireless operator's position today. Those who intelligently follow the progress of modern events will not need to be informed of the international recognition as a safeguard on the high seas radio-telegraphic communication is receiving.

The steadily increasing demand for qualified ship operators and land station operators, directly resultant upon legislation which provides that a licensed wireless operator shall be continuously on duty, making a second or relief man necessary, was realized by Vincent T. Thomas, principal of The Massachusetts College of Telegraphy at 899 Boylston St., Boston, Mass. With the advent of the first license law in 1911, this school at once recognized the valuable and practical utility of a wireless institution which could specialize in the preparation of licensed operators for Government and Commercial services. To this end the college has been steadily compiling a system based upon the entire series of questions (both practical and theoretical) submitted at The Charlestown Navy Yard during the various first-class operator's license examinations, with the result that it has long since received the hearty endorsement of The Marconi Wireless Telegraph Company, which company is at present hiring its operators directly from the classroom of "M.C.T." after first-grade licenses have been secured by the graduates.

The college is now making a special lecture feature of The Marconi Auxiliary Storage Set, and the student is trained in its care and manipulation. The institution is already in possession of a standard auxiliary set which is operated by the student when competent, in addition to the regular loosely coupled 1 k.w. station.

The principal is informed by the Boston Marconi Manager that the company was never in greater need of good reliable men as a result of the dual operator law.

Amateurs are very cordially invited to visit the school during session hours, and will be given permits to visit some of the many ship station M.C.T. graduated operators, who sail from Boston port.

Mr. Thomas is particularly suited to take charge of an institution that has already earned the reputation of faithfully studying the best interests of student and company alike, having been one of the pioneer operators to serve with Manager A. E. Taylor under Signor Marconi at the time of the installation of M.C.C. long distance wireless station at South Wellfleet, Mass.

New England Wireless Society Meeting

The New England Wireless Society met January 4 at Harvard University to listen to a very interesting talk by Prof. G. W. Pierce assisted by Dr. E. L. Chaffee on the subject of "Resonance in the Receiving Set." The talk was illustrated by various physical and electrical experiments, including an oscillagraphic device for producing a visual record of the oscillations as actually occurring in a wireless telegraph transmitter. After the talk an informal discussion as to the probable and to what extent permissible amateur interference should take place under the provisions of the new law.

The next meeting will be held at 8 p.m., February 1, at the Walker Building, of Massachusetts Institute of Technology, corner of Boylston and Clarendon Sts., Boston. Dr. Reginald Fessenden will address the society. Other notable speakers of the year include Prof. A. E. Kennelly, who has done so much excellent work on high potential A.C. Information regarding the society may be obtained from Mr. E. W. Chapin, 43 Thayer Hall, Harvard University, Cambridge, Mass.

The following letter shows in a very practical way the appreciation of the L. S. Starrett Co. for the faithful work and co-operation of its employees:

To Our Employees:

The past year has been one of prosperity and progress.

The gradual and steady increase in our sales is gratifying, but not less significant and encouraging is the manifest improvement in conditions inside the factory.

Our employees have shown that they appreciate more than ever before the fact that their interests and the Company's are identical; that Quality in our product is the chief thing—the indispensable thing—and that next are efficiency and loyalty on the part of our co-workers.

When a man gets over the idea that he is paid for simply putting in so many hours a day and turning out just enough work to get by, and puts intelligent, interested effort into what he does, and even gets a bit enthusiastic over finding a way to improve the quality or increase the amount of his production, his value to the Company is largely increased, and he is in a way of making much more of a man of himself. We want men, not human machines; not time alone, but brains. A man who is worth twenty dollars a week takes up no more room than one who is hardly worth ten. We are glad to repay increased efficiency by increased wages. We have made many increases in pay during the year for this reason.

We feel, however, that the increase in efficiency due to intelligent and interested industry in our plant during the past year has been so general and has been such an important factor in the healthy growth of our business, that we may well make some special recognition of it at this time. It was therefore voted by our Directors at a meeting held the eleventh instant, to pay, as soon after the first day of January, 1913, as practicable, *to each person in the employ of the company on that date, a sum equal to two per cent. of the entire amount of wages paid to such employee during the year* 1912.

THE L. S. STARRETT CO.
Athol, Mass., 20 December, 1912.

The Massie Wireless Telegraph Co., located in Providence, R.I., advise us that they have sold out to The Marconi Wireless Telegraph Co. of America, and are disposing of all their extra instruments and parts at a very low figure. All those interested in wireless instruments or parts of wireless instruments had better communicate at once with this firm, whose advertisement appears elsewhere in the pages of our magazine, as they will no doubt make quick sales of the stock on hand. It will be "first come, first served."

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If you will simply send me your name. Special Introductory FREE Offer. Six fine Monthly Issues—each worth $10 to $100 to you.

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Why you should get **Investing for Profit:** Only one man in a thousand knows the difference between the *rental* power and the *earning* power of his money. Few men know the underlying principles of incorporation. Not one wage earner in 10,000 knows how to invest his savings for profit, so he accepts a paltry 2% or 3% from his savings bank, while this same bank earns from 20% to 30% on *his money*—or he does not know the science of investing and loses his all.

Russell Sage said: "There is a common fallacy that, while for legal advice we go to lawyers, and for medical advice we go to physicians, and for the construction of a great work, to engineers—financing is everybody's business. As a matter of fact, *it is the most profound and complicated of them all.*"

So let me give you just a glimpse of the valuable investment information you will get in my six big issues, "The Little Schoolmaster of the Science of Investment," a guide to money-making:

The Science of Investment.
The Root and Branch of the Investment Tree.
How to Judge a Business Enterprise.
Where New Capital Put Into a Corporation Really Goes.
"Watering"—Its Significance.
Idle Money vs. Active Money.
Capital Is Looking for a Job.
The REAL Earning Power of Your Money.
Investment Securities Are Not Investment Opportunities.
The Actual Possibilities of Intelligent Investment.
The Capitalization of Genius and of Opportunity.

Wait till you see a good thing—but don't wait till everyone sees it. You will then be too late. Never was a time more auspicious for a public campaign of education on the logic of true investment. A revolution in the financial world is now going on—to the profit of the small investor.

You are now face to face with your

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If you know how to invest your savings—if you know all about the proposition in which you are about to invest your hard-earned savings—you need no advice. But if you don't, if there is a single doubt or misgiving in your mind—I shall be pleased to answer any inquiries you may make, or furnish any information I can regarding the art of saving and making money through wise investment.

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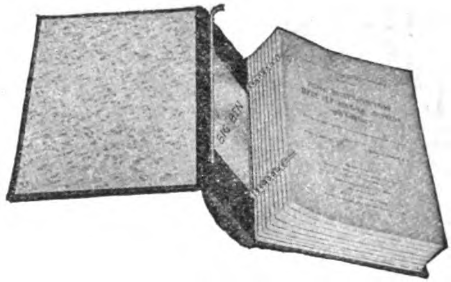

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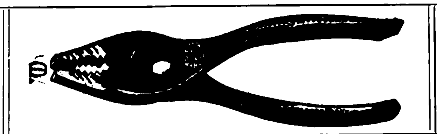

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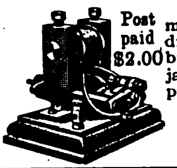

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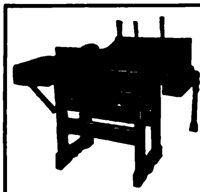

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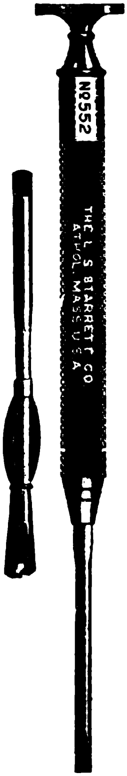

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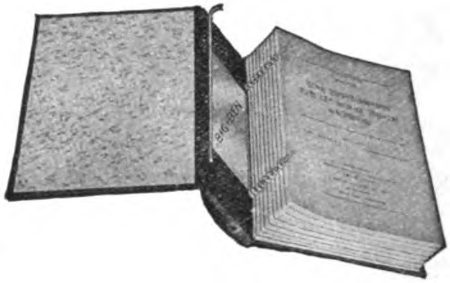

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VOLUME XXVI MARCH, 1913 NUMBER 3

CONSTRUCTION AND OPERATION OF A DECREMETER

A. S. BLATTERMAN

In the January issue of ELECTRICIAN AND MECHANIC, Mr. H. B. Kirtland explained a method of determining the logarithmic decrement. As he points out, there are required for the work (1), a calibrated wave-meter, and (2) either a calibrated hot-wire ammeter or a low-resistance galvanometer and platinum-tellurium thermo-element.

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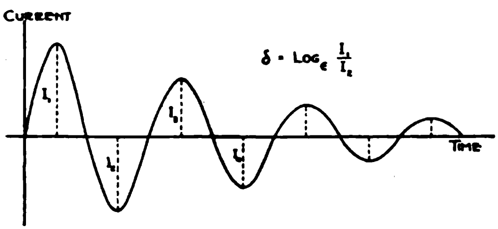
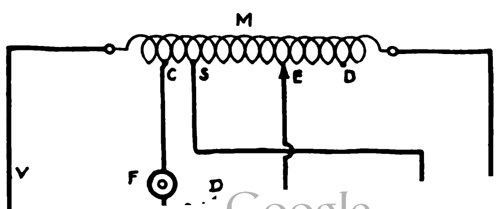


Fig. 1

telegrapher who seldom has access to apparatus of the above character. And, moreover, granting the availability of the necessary apparatus, the final determination of the damping coefficient necessitates calculation. I therefore recommend the following apparatus and methods, adapted from the Marconi decrement determinations, to be used by the amateur, and these in at least one instance permit the reading of decrement direct from a table which is here furnished for the purpose. In another instance the plotting of the resonance curve and a tially one which involves a determination of a relation between the current values in the wave-train and the time or period of oscillation. This is evident to students of the subject. Though this may at first seem to be a rather hopeless task, a little thought will show that while it may not be possible directly to measure instantaneous current values or to take the time of oscillation, the effects produced by the current and the elements governing the frequency are both easily accessible and definitely observable.

To be explicit, the phenomenon of resonance is made use of exactly as is done in wavemeter work, and with a few alterations and additions to the latter an instrument constructed which allows direct determinations of the logarithmic decrement. Such a piece of apparatus is known as a decrement meter or simply a "decremeter."

It involves primarily a fixed inductance and a variable capacity, and in this respect it resembles the wavemeter. In fact, if the values of inductance and capacity are known, wave-lengths may be read from the decremeter as precisely, though perhaps not so readily, as from



the wavemeter itself. Both are instruments involving the resonance phenomenon and incorporating a means of quick and accurate adjustment to different frequencies. However, the decremeter (here described), not dealing with the actual numerical values of frequency and wave-length, need not have its high-frequency units evaluated, although some consideration must be given to this feature of the instrument in its design. For the special use of the amateur it must be applicable to the measurement of decrements occurring in impulses whose wave-lengths are 200 meters or less. The following instrument is suitable.

APPARATUS

A schematic diagram of apparatus and connections is shown in Fig. 2. The apparatus there indicated is as follows:

K=Adjustable condenser
F=75 ohm head telephone
D=carborundum detector
M=a long coil
N=a shorter coil.

Also there will be required a double-pole, double-throw switch.

The long coil M is constructed as follows: Turn up a round wooden mandrel 12 in. in length and ½ in. (scant) in diameter and leave the surface of the wood unfinished—that is, do not paint it or use shellac. Wind with one layer of No. 22 d.c.c. wire B.&S. gauge starting and finishing 1 in. from the ends. As the winding proceeds apply a good glue to the mandrel and wind the wire right in it. Take off a tap 26 turns from one end of the finished winding and another one 52 turns from the same end and bare the wire for the sliding contact shown at E, in Fig. 1. C and S in the diagram represent the points of tapping. The finished coil may be mounted in any convenient manner, but precaution should be taken to so arrange matters that a short indicating pointer attached to the handle of the slider may move over a scale which should be laid out thus.

On the strip of paper or celluloid which is to serve as scale lay off a distance of 8 in., and divide it into 100 equal parts. Mount the scale so that its zero mark will be exactly opposite the point marked C on the coil and its 100 mark at some point D (see figure).

The smaller coil N has the following dimensions:

26 turns No. 22 d.c.c. wire, B.&S. gauge on wooden mandrel 1¾ x ½ in. This coil has no slider or taps. All that is necessary is to bring off the two terminal wires to the connecting points shown in the diagram.

The adjustable capacity should take the form of a rotary condenser of the semi-circular plate type. Its capacity (maximum) should be about 0.0005 microfarads, and any of the several condensers of this size now on the market is suitable.

This completes the apparatus required and it should be wired up as shown.

MANIPULATION

Turning now to the manipulation of the apparatus and the methods to be employed in the definite determination of the decrement, there are two separate processes which recommend themselves. The first excludes the use of the small coil N, and is dependent upon the plotting of a resonance curve. The second is more mechanical and more rapid, though it lacks some of the instructiveness to be gained from the plotting of the tuning curve. In either case the underlying principles are the same.

Method I.—It is assumed that when a long coil, such as M is subjected to the passing of high-frequency oscillatory currents, the potential along it varies in direct proportion to lengths along it—*if the ends of the coil are neglected.* Therefore, referring to the figure, the greater the distance separating C and E, the greater will be the potential difference at the detector terminals.

Set up the instrument some little distance from the transmitting antenna circuit and excite the latter. Throw the switch to position 1—2, and with the slider E at about 50 on the scale, adjust the rotary condenser until the signals in the phone are loud. Now diminish the scale reading of E, *i.e.*, move the slider toward the point C, and at the same time alter the condenser for maximum signal strength. Continue this until a point is reached where the signals are a little more than barely audible.

Note exactly the reading CE and the reading of the condenser. Now change the reading of the latter a few degrees, say from 2 to 5 degrees, depending on the proximity and power of the transmitter.

This will cause the signals to disappear. Bring them back again to their original strength by adjusting slider *E*, making reading *CE* larger. Again note this latter reading and the corresponding condenser position.

Repeat the above, making slight reductions in the condenser capacity and subsequent adjustments of the slider for signal audibility until the value of *CE* is large (about 80 or 90). Note each set of component readings of condenser and slider scales and enter the values in a table of the following form.

CE	$\frac{1}{CE}$	Condenser Readings in Degrees = *R*	Square Root of Cond. Read's = $\sqrt{R}$

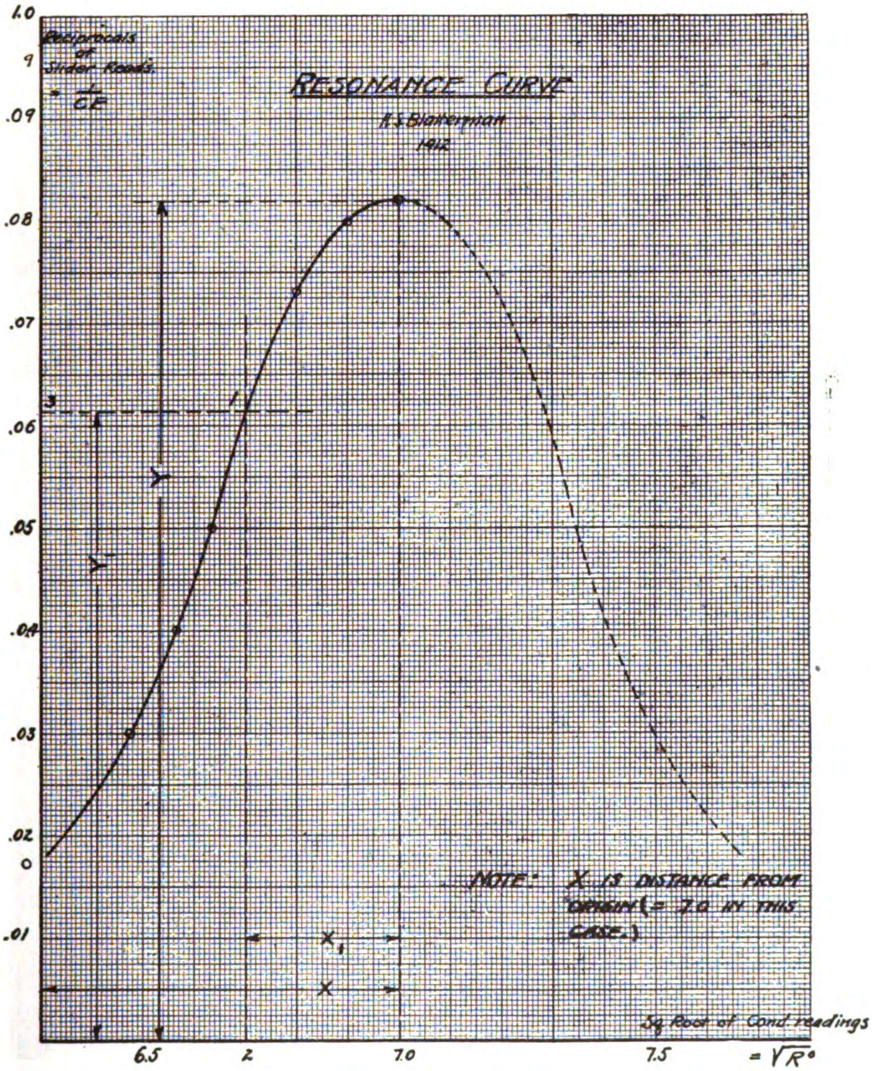


FIGURE 3.

The two columns headed respectively "*CE*" and "Condenser Readings=*R*" contain the observed values, while the other two columns are computed as indicated.

As above stated, the potential along

the coil M varies in direct proportion to lengths along it; that is, the potentials impressed upon the detector, and consequently the strength of the signals are directly proportional to the values of the scale readings CE. It is plain then that the smaller CE is made, the more nearly must the circuit of the decremeter be brought into resonance with that of the transmitter—if the detector and telephone are to respond; and when CE has attained the smallest possible value at which the signals are still audible and the condenser adjusted accordingly, then the decremeter circuit is oscillating in a period identical with that of the transmitter. This is the initial setting and affords the first set of readings.

Now as K is changed more and more from this first resonance position the circuit is thrown continuously more and more out of exact "tune," and more wire must be tapped off the coil M to obtain current sufficient to actuate the detector.

The method of procedure then is to calculate the reciprocals of the readings CE, since as K is changed the current values in the circuit $MVKI$ diminish and CE increases. Also since the wave-length is directly proportional to the square root of the capacity ($\lambda = 2\pi V\sqrt{LC}$) and since the latter is directly proportional to the scale readings on the condenser we may compute in each case the square root of the condenser readings in degrees ($=\sqrt{R}$).

Having done this the next step is to obtain a piece of cross-section paper and as shown in Fig. 3 plot the values of $\frac{1}{CE}$ against the values of $\sqrt{\text{Cond. readings}} = \sqrt{R}$. The curve obtained is one-half of the resonance curve, and is all that is needed for our purposes. Now select some point on the curve as "1" and draw through it a horizontal and a vertical line, cutting the co-ordinate axes in points 2 and 3. Read off directly the distances marked respectively $X_1—X$, $Y_1—Y$, and substitute in this formula

$$\delta = 3.1416 \frac{X_1 Y_1}{X\sqrt{Y^2 - Y_1^2}},$$

which gives with accuracy the required value of the logarithmic decrement.

One word of caution. Care should be exercised in the selection of the point "1" on the curve. It should be so chosen that the value of the ratio $\frac{X_1}{X}$ in the formula shall not exceed $\frac{1}{20}$. As an illustration, let us take the case actually plotted in Fig. 3:

$$X = 7.0$$
$$X_1 = 0.3$$
$$Y = 0.082$$
$$Y_1 = 0.0614$$

Substituting in the formula:

$$\delta = 3.1416 \frac{0.3 \times 0.0614}{7.0\sqrt{(0.082)^2 - (0.0614)^2}}$$
$$= 0.147$$

One objection to this method of determining the decrement is that time is consumed in plotting the curve and errors may enter in the subsequent determination of the values required for computation. It is, however, interesting physically, is quite applicable to observations on slightly damped impulses, and is in use in commercial work.

The following method is more expeditious:

Method 2.—Set the detector, throw the switch in position 3–4, and adjust the condenser K for maximum signal strength. Do not have the decremeter too close to the circuit being measured, or the final value of damping obtained will be larger than the true value. When, by adjusting the condenser, a maximum response is obtained in the phone, note carefully its intensity, fixing the strength and character of the sound firmly in your mind.

Then throw the switch to position 1–2, having previously moved the slider E up very close to position C of Fig. 1. It will be seen that the switching change has cut the small coil out of the circuit and as a result the wave-length of the instrument is shortened and the signals are no longer audible. They may, however, be brought back, as in *Method* 1, by means of the slider E; and this is the method of procedure.

Move the slider back from C toward D until the strength of the signals is just what has previously been observed with the switching connections at 3–4. It is not difficult to thus establish and recognize two sounds of equal intensities, and the process is quite rapid.

Note the reading CE on the scale under the slider when this is accomplished, and refer to Table II, from which the value of the logarithmic decrement can be read directly.

TABLE II

CE	δ	
25	Infinitely Large	
30	0.189	
31	0.172	
32	0.157	
33	0.146	
34	0.136	
35	0.129	
36	0.121	
37	0.115	
38	0.110	
39	0.105	
40	0.100	Legal limit
41	0.097	
42	0.093	
43	0.090	
44	0.087	
45	0.084	
50	0.073	
55	0.064	
60	0.058	
65	0.052	
70	0.048	
80	0.041	
90	0.036	
100	0.032	

It may be well to state that better results will be obtained if the decremeter and transmitting apparatus are rather widely separated so that the signals resultant are not overintense. It is much easier to compare two weak sounds than two strong ones.

The above method (2) is that embodied in the operation of the decrement meter manufactured and used by the Marconi Company, and is to be recommended on account of its quickness, accuracy and simplicity.

The values of δ determined by the methods of this paper are decrements per half period, *i.e.*, for one single oscillation.

How to Wind Irregular-shaped Springs

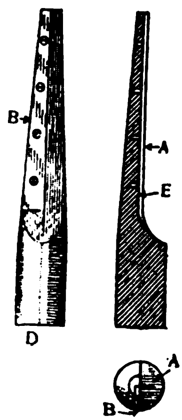
A writer in *Popular Mechanics* gives the following method of winding springs shaped like those on stove lifter handles, stove doors, etc., having made a tool as shown in the illustration and used it in his lathe with good results.

Each piece A is made of spring steel and riveted to a shaft with two rivets on one end, while the other end fits into an individual notch in the collar C. This collar is kept from turning on the shaft

by a key. Turning nut B up against the collar pushes on the ends of the springs, causing them to bulge outward in the middle. When the proper size is secured on these springs, one end of the wire is fastened to it and the coil is wound. When through winding, loosen the nut and slip the finished coil over the opposite end of the shaft from the collar.

A Taper Reamer for Roughing Out Holes

The drawing herewith reproduced shows a first-class reamer for roughing out all kinds of tapered holes for valves and petcocks. The shank and cutter holder D is turned from tool steel to within 1/32 in. of the size wanted, then milled as shown at A. A second cut is taken on the milling machine, as shown at E, leaving a recess to take the cutter blade B. The screwholes in blade should be a little large to allow adjustment for wear, which can be taken up with strips of paper inserted behind it. The holder and blade must be



A Taper Reamer

MECHANICAL DRAWING

P. LEROY FLANSBURG   L. BONVOULOIR

ISOMETRIC PROJECTION

In one of the previous articles of this series, it was shown how an object could be represented on two or more suitably chosen planes. Frequently it is desired to produce a pictorial effect when representing an object and at the same time to preserve the relative proportions of the various parts, in order that they may be drawn to some suitable scale. One of the most common methods or systems of doing this is called *isometric projection* or *isometric drawing*. This method requires but a single plane of projection.

In *mechanical drawing* the object is represented on two planes which are called the horizontal plane of projection and the vertical plane of projection. Very often a third plane is also used as

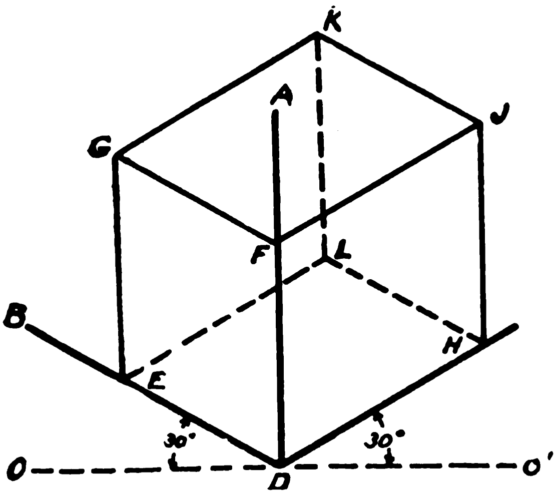


Fig. 1

a plane of projection, and this plane is taken perpendicular to the other two planes. The projections of the object on these three planes are termed the plan, the front view and the side view of the object.

In *isometric projection* or *isometric drawing* it is not necessary to show these

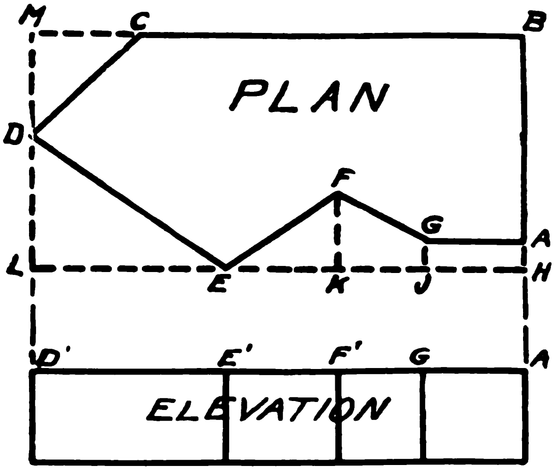


Fig. 2

several views and the plan of the object, and instead, a representation is made of the object, the view being taken, as it were, cornerwise to the observer. In other words, the lines belonging to the three systems of parallel edges which bound all rectangular objects, are drawn parallel, respectively, to three axes called the *isometric axes*. This fact is illustrated quite clearly in Fig. 1. The figure shows the *isometric* representation of a parallelopiped.

To obtain the *isometric projection*, it is supposed that the solid is so placed relatively to a plane surface that the

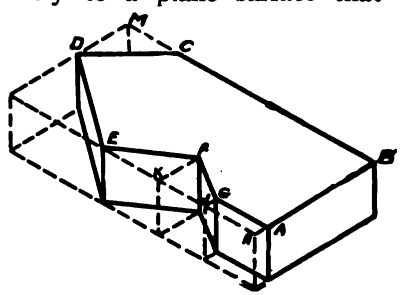


Fig. 3

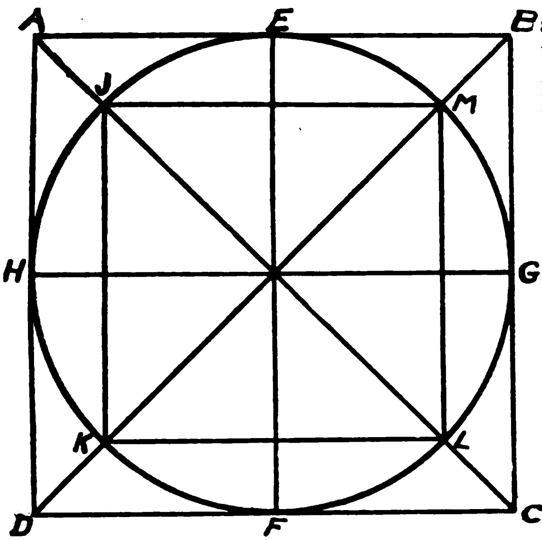


Fig. 4

three surfaces forming the solid angle *D* in Fig. 1 are equally inclined to the plane and that the solid is projected into the plane, by projectors which are perpendicular to the plane. The lines *BD*, *AD* and *CD* are called the *isometric axes*. The lines *BD* and *CD* make angles of 30 degrees with a horizontal, while the line *AD* is drawn vertical. When an *isometric projection* is made, it is evident that all edges of the figure or object which are inclined to the vertical projection plane, appear shorter than they actually are on the object. The length of an edge of the object is to its isometric length as $\sqrt{3}$ is to $\sqrt{2}$. Since all edges are equally foreshortened, it is usual, for the sake of convenience, to make the lines in an *isometric drawing* equal to their true length. It is not possible to measure directly the angle between lines on an *isometric drawing*. In any case of *isometric drawing*, the following rule is

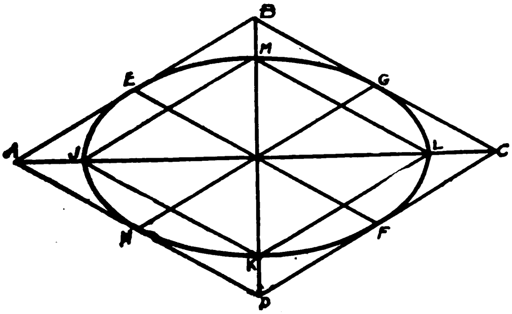


Fig. 5

adhered to, that all horizontal edges of the object are represented by lines making 30 degrees with the horizontal, that all lines are drawn to the same scale, and that there is no "vanishing." The distinction between an *isometric projection* and an *isometric drawing* lies in the fact that the *isometric projection* has all of the lines drawn 0.814 of full scale size, while in the *isometric drawing* all lines are drawn to full scale size.

In *isometric drawing* invisible lines are usually omitted to avoid confusion. It is customary to draw shade lines for the division between light and dark surfaces, and the direction of the light is at 30 degrees downward to the right.

When making an *isometric drawing* of any irregularly shaped object, the object should be enclosed in a rectangular

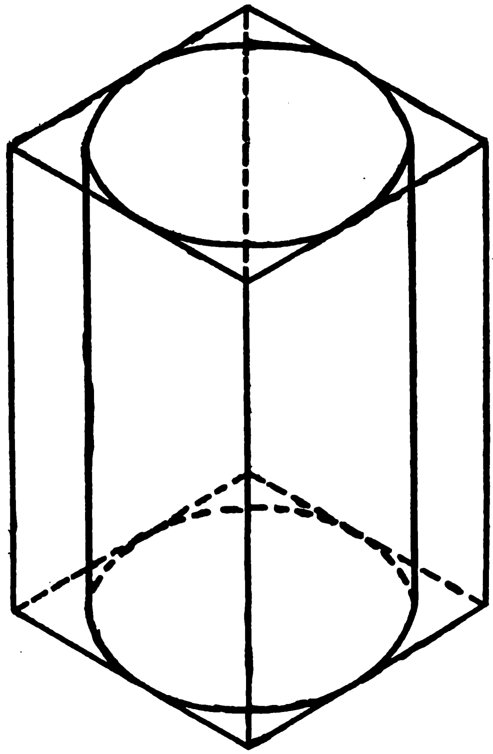


Fig. 6

solid and the *isometric drawing* of this solid should be made before making that of the irregularly shaped object. After the *isometric drawing* has been made of the rectangular solid, it is a comparatively easy matter to inscribe the *isometric* of the irregularly shaped object.

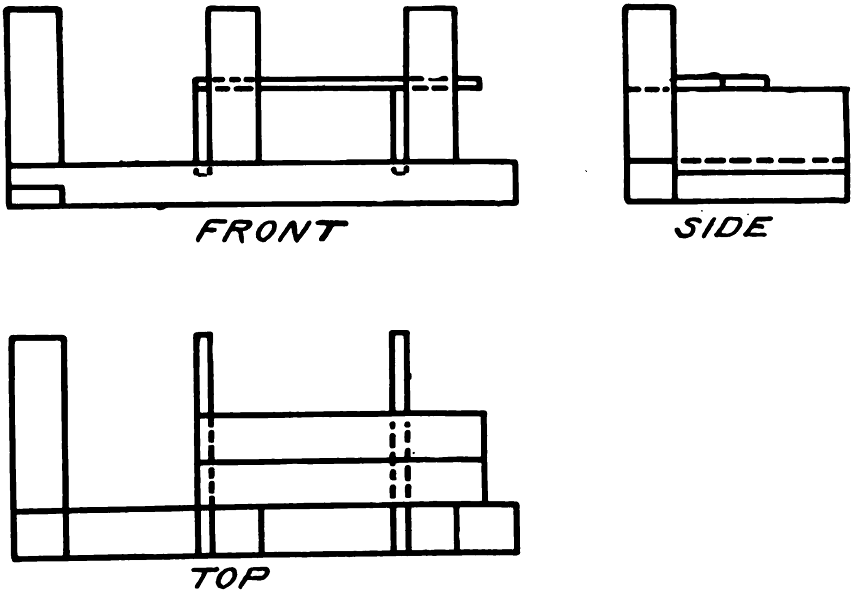


Fig. 7

The method of making such an *isometric drawing* is shown in Figs. 2 and 3. Fig. 2 shows the plan and elevation of a given irregularly shaped solid. *BCMDLEKJHA* is the plan of the enclosing rectangular solid. Fig. 3 shows the *isometric drawing* of the two solids.

Figs. 4 and 5 show the method of drawing the *isometric* of a circle. Fig. 4 shows the given circle. About this circle, describe the square *ADCB* and draw the diagonals and diameters of the square. Through the points at which the diagonals cut the circle, draw lines as *JK*, *KL*, *LM* and *MJ* parallel to the sides of the square *ADCB*. To put both squares into the *isometric projection*, Fig. 5, make all lines a similar length, *i.e.*, *AD* in the first figure equal to *AD* in the second figure, *BC* in the first figure equal to *BC* in the second figure, etc. Now draw the diagonals and the diameters. Having thus located eight points through which the curve representing the circle will pass, draw in the curve either freehand or by the use of French curves. The *isometric* of a circle is an ellipse, the exact construction of which would require the locating of a large number of points.

Fig. 6 is the *isometric* of a cylinder which is standing on its base. The cylinder is circumscribed by a square prism and the ellipses which form the top and base of the cylinder are simply circles drawn in *isometric projection* by the method just described.

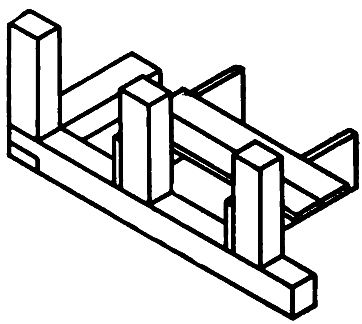


Fig. 8

Fig. 7 is the front, top and side elevations of some carpentry work. The *isometric* of this same piece of work is shown in Fig. 8. To obtain this *isometric drawing*, it is simply necessary to follow the general principles described in the early part of this article. It should be noticed that the *isometric drawing* gives a more complete but less detailed picture than does the *mechanical drawing*. For this reason *isometric drawing* does not pretend to supplant the ordinary *orthographic projection*. It is largely used when making sketches of machines and details, since it is often better and more time-saving than is the system of making the three ordinary views. It is particularly well adapted to any work which

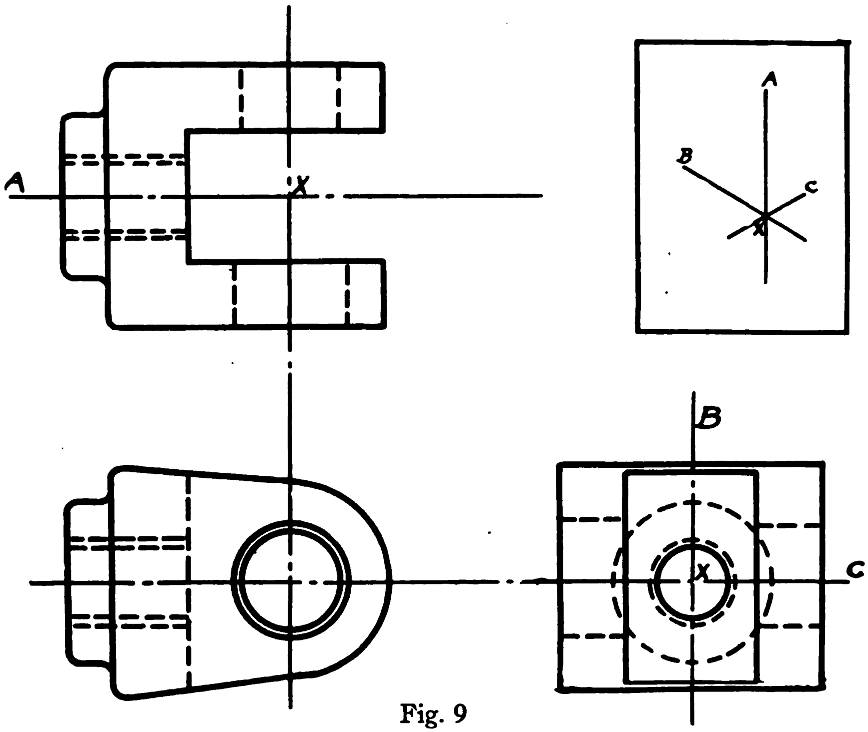


Fig. 9

does not require a view of the internal construction of the object.

The problem for this month will be to make the *isometric drawing* of the connecting rod strap illustrated in Fig. 9.

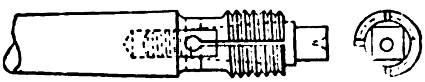
The three axes are $A{\cdot}X$, BX and CX. The *isometric drawing* should be drawn first in pencil, then in ink, and of such a size as will make a well-balanced plate. The outside dimensions of the plate are to be 10 x 14 in.

A MANDREL FOR FACING NUTS

F. C. S. STUDENT

The shank of this mandrel is turned taper to fit the lathe spindle; then a hole is drilled, and turned out taper, the bottom part of the hole being left straight and tapped out. Then the thread is cut on the outside to fit the nut.

At back of the thread, two holes are drilled crosswise and slots cut into the



Mandrel for Facing Nuts

holes. The screw is turned to fit the taper hole, and the end is squared to apply a wrench. The end of the screw may be centered and hardened so that the tail-stock center may be brought up to support it.

This kind of mandrel can also be used for turning small castings having a reamed hole. In that case, instead of the thread on the outside, the end is turned to fit the hole, so that the casting can be pushed on.

When the screw is tightened, the mandrel expands, and the nut or casting is held tight.—*American Machinist.*

Wireless Operator Killed

FIRST CASE ON RECORD—MAN AT GREAT GERMAN STATION THE VICTIM

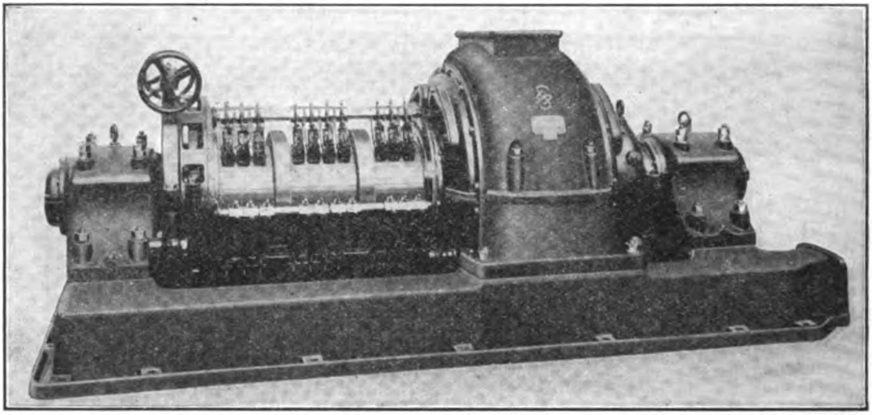
New York, December 24.—Wireless operators here say that the death of an operator in the great German wireless station at Norddeich, near the North Sea, on Sunday, is probably the first case on record of a wireless operator being killed at his post. The Berlin dispatches indicated that the operator, a man named Mueller, must have carelessly come into contact with the wires employed for the creation of electric waves, which are charged with such powerful voltage that death comes instantaneously to anyone touching them.

MODERN GERMAN STEAM TURBINE GENERATORS

FRANK C. PERKINS

It may be of interest to study the construction of the steam turbine generators of German design of both alternating and direct current type, and note the method employed for keeping the windings cool during heavy load.

The accompanying illustration shows each phase is 724 amperes. Exciting current is conducted to the slip-rings at a pressure of 220 volts, the exciter dynamo being directly coupled to the extended shaft of the alternator outside the main bearing and mounted on the extender sub-base.



a direct current generator of the Siemens-Schuckert type supplying a current at 110, 440 and 600 volts at the Zentral Krefeld. It is directly coupled to a Zolley steam turbine having a capacity of 1,950 h.p. It will be noted that to collect the heavy current—1,135 amperes—a very long commutator is used, and to provide against the great centrifugal stresses when revolving at a speed of 3,000 revolutions per minute, steel rings are shrunk on over the segments in several places. Mica insulation separates the rings from electrical contact.

This armature is constructed in the form of a ventilator or blower, the current of air being forced through and around the windings by the rotation in the same manner as a ventilating fan or turbine blower.

The ventilation of the rotating field

Short Rules for Price Making

To figure the profit on an article correctly, subtract cost from selling price, divide the result decimally by the selling price and the result will be the true profit. Thus: Cost, Rs. 10; selling price, Rs. 15; profit, Rs. 5; and Rs. 15 is contained in Rs. 5 .333 times, showing a profit of $33\frac{1}{3}$ per cent., and not 50 per cent., as some think. The same calculation applies in making so many percent. discount on your clearance sale.

We give the following short and simple way by which goods can readily be marked at any of the percentages common to business:

"To make a profit of $16\frac{2}{3}$ per cent., add 20 per cent. to cost.

"To make a profit of 20 per cent., add $33\frac{1}{3}$ per cent. to cost.

... $33\frac{1}{3}$ per cent.,

ACTION OF HYTONE GAP

ASHLEY C. ZWICKER

A quench spark is one which causes the primary oscillation of a radio transmitter circuit, that is the condenser, the spark gap, and the primary of the helix, to cease oscillating when the secondary of the helix has attained its full amplitude of oscillation. A sketch will illustrate this fully. Fig. 1 shows the primary and the secondary oscillations of an ordinary spark set in which the primary excites oscillations in the secondary, which in turn again renews the train of oscillations in the primary circuit. This causes serious loss of energy from the heating of the spark gap, due to the constant sparking. Fig. 2 shows the primary and the secondary oscillations of a quench spark system. This is attained when the spark gap quickly cools sufficiently to cause the path of the previous spark to assume its natural high resistance. In this case the primary oscillations cease, while the secondary circuit continues to oscillate at its own natural period until the energy in it has been radiated.

The quenched spark is very efficient and is much sought for wireless work; and when we can combine the quenched spark with a high-pitched note, we have two very important assets for good wireless work. This high-pitched note has been produced in several ways. We have the shunted arc, the rotary gap, and the high-frequency alternator. Each has its advantages as well as its disadvantages. The shunted arc requires direct current of an uncommon voltage and needs very careful and constant attention. Besides, the oscillations are of the ultra audibility variety, being far above the reach of the human ear or the sensitiveness of a telephone diaphragm and requiring to be broken into groups at either the receiving or the sending end. The 500-cycle alternator used by the Telefunken Company has the disadvantage of not being able to work to the higher powers. This set works on the principle of one spark per alternation, and so the whole energy stored in the condenser per alternation is discharged across the gap in one spark. This spark makes its first jump at one point, and when larger powers are used, the energy is sufficient actually to tear out small bits of the copper surface of the gap, causing poor quality of tone and lower efficiency.

The new "Hytone" gap, as manufactured by a well-known firm engaged in construction of wireless apparatus, has several marked advantages which we will here enumerate. First: The gap can be worked on any commercial frequency of alternating current, thus doing away with the expensive special alternators on motor generator sets. Second: The potentials used in connection with the gap are very low, insuring safety of

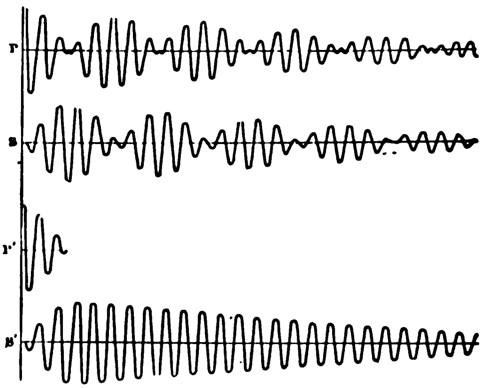


Fig. 1—P. and S. Primary and Secondary, Ordinary Spark.
Fig. 2—P'. and S'. Primary and Secondary, Quenched Spark.

handling and eliminating breakdown of condensers. Third: Efficiency is very high with this type of gap, comparing favorably with any commercial apparatus now in use and being approximately double that of the ordinary spark set. Fourth: The gap is practically noiseless in operation, doing away with the loud reports and flashes of the spark sets.

Patents have just been allowed for the method of producing the tone effects as well as covering several of the mechanical features of the gap. The gap consists primarily of two segmented copper discs, one stationary and the other rotary. The condenser discharges across the gap (which, but for the segments, would be continuous throughout each alternation) are divided into groups, the number of groups per second producing

the tone. The discs are made of copper, as copper is a better conductor of heat than other metals except silver.

We shall here consider the gap designed for a 1 k.w. set. In this gap each disc has 36 segments and a speed of about 1,800 revolutions per minute. This gives us about 1,080 groups per second, or 8 per alternation, 16 per cycle. Each group has 25 to 30 highly damped sparks, depending on the amount of condenser we are using. Were we rotating plain discs instead of segmented ones, we should have not groups but a continuous train of damped sparks throughout each alternation of a frequency of about 60,000. These are reduced, due to the segments, to about 30,000, but this, as we know, is above audibility and of practical use only for telephone work.

This same gap may be used with direct current of 1,000 volts, and will show

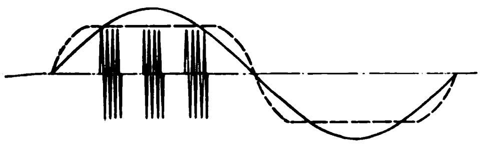


Fig. 3—Action of Gap and Voltage Across it

slightly better efficiency than the alternating current. In fact, the advantage of direct current over alternating current seems to be great enough to justify, in larger sets at least, the installation of a mercury arc rectifier. But the sets so far manufactured are for alternating current 60 cycle, and operate with an efficiency of 60 to 70 per cent., producing a high-pitched note. The rotating disc constantly brings cool copper in place of the heated spot, thus keeping up the high resistance of the gap and producing the quenching of the sparks. Also, instead of the whole energy of one alternation's being discharged at one time, it is discharged in 8 groups, or 250 sparks, thus allowing higher powers to be used.

A sketch will perhaps show the action of the gap and the secondary voltage across it. The magnetic leakage transformer is so constructed that the secondary voltage does not follow the sine curve of the supply but assumes a form following closely the heavier line of the sketch. From the beginning of the cycle the potential rises rather sharper than the true sine curve, but as the iron approaches saturation the curves flatten out, being flat on top and continuing so until almost the end of the alternation, then dropping sharply as at the beginning. Of course, working under load, the potential across the terminals and the gap is the same, and when a spark passes, or about 200 times per alternation, it is about zero.

This rapid rise and fall of potential cannot follow the windings far into the coils, but is choked, causing an actual difference of potential of full secondary voltage across a comparatively few turns at each end of the coil. To counteract this, the first and the last 250 turns of secondary winding are spaced with extra insulations between layers. This effect is usually spoken of as the high-frequency current backing into the secondary. In operating the Hytone gap, the manufacturers strongly recommend adjusting the length of the gap while not in motion, as otherwise there is liability of the two discs' running together, the segments interlocking and causing serious damage to the gap.

It should be stated in passing that the shorter the gap the higher the efficiency will run, but the set should not be run on short gap when out of tune, as the whole energy is then being used up in heating the gap, and the copper will expand, causing the discs to catch, as mentioned before.

An interesting and instructive apparatus for studying the frequency of oscillations can be made by rotating a vacuum tube at a speed about synchronous with the speed of the Hytone gap. By connecting the tube through the bearing with one side of the gap, the tube will be lighted at each group of sparks; and by observing closely in a dark room, the number of sparks per group may be noted. The tube may be enclosed in a box painted black inside with a window for observation, the tube being mounted on a disc inside the box and belted to a motor mounted on top. Or, if one has not the extra motor, it may be driven by the same motor that runs the gap by means of a rubber band around one of the coupling discs.

You have *pleasure* when you please another—*profits* are shared by you together.

NOTES ON THE USES OF ANGLE-PLATES

ALFRED PARR

The term "angle-plate" is given to an accessory much used in every workshop where metal is tooled—from the heaviest class of marine work down to the smallest model. It is usually made of tough cast iron, and has its adjacent sides accurately machine-faced, so as to form a right angle (90 degrees). These most useful appliances deserve consideration, and for convenience may be classified in two sections. First, those employed on rectangular surfaces at the planing, shaping, and milling machines, also for supporting work to be bored or drilled. The second class can be called "lathe angle-plates," which, indeed, are capable of a further division, as those employed on general lathe work, and those made expressly for special work at the lathe.

It will be seen that there are advantages to be obtained by these distinctions peculiar to each section. For instance, it frequently occurs that almost every available inch in a rectangular angle-plate is in requisition when certain classes of work are to be planed or milled, and the same may be said when it is required to support the same pieces of work at the drilling or the boring machine.

This inconvenience, however, is not so general in lathe work, hence the necessity for the above divisions. It will not be without interest to discuss some forms of plates designed for general work, in the first place, and consider those of a more special character afterwards. Figs. 1 and 2 illustrate an ancient and a modern angle-plate respectively. Fig. 1 has had its weak back broken through too much coring in the pattern—a defect to be again referred to.

It will be seen that Fig. 2 is a more typical design—the length of the plate is about twice the depth; it is provided with cored slots of a rectangular form, spaced at fairly uniform intervals; there is a good fillet, and each end is tied with a substantial web to prevent any possibility of warping. This plate was recently purchased; its weight is 47 lbs., and for general work at the planing machine, the shaper, or drill it is quite in place, and is none too strong to resist all the strains to which it is there subjected. Now a ¾ in. bolt, having a squared neck, is a little over 1 in. measured diagonally, and although ¾ in. bolts are very strong, yet there is no margin of material left to prevent their turning even when used in an angle-plate 7 x 7 x 15 in., such as is given in Fig. 2. When this happens, it is necessary to hold a spanner on the head of the bolt to prevent its turning; but the work is frequently of such a character as to require holding in position, and a second pair of hands must be engaged to assist with it. This is always best avoided, and, indeed, could be in the above case if the slots in the angle-plate were of a smaller size.

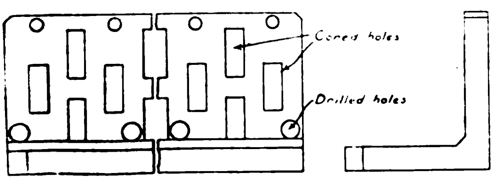


Fig. 1. Showing a Weak Angle-plate

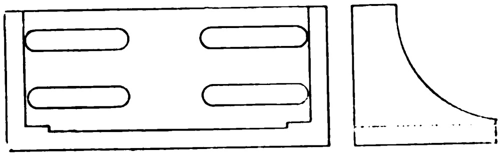


Fig. 2. A Modern Angle-plate

Why is it that cores 1 in. wide should be put in so small a plate? The only answer is—that there is no agreement in the dimensions of the slots in machine table, therefore the slots in angle-plates are made to agree with the largest tables. Our readers may never require an angle-plate weighing 47 lbs., but they will require true and reliable plates nevertheless. Such plates may be purchased or "made to order," but are better still if made by the amateurs themselves. Small angle-plates can be cast and tooled, leaving out the consideration of holes until their proper position can be located; then, and only then, should holes be drilled. By thus carefully considering how the plate is to be fastened down on one face, and how the work can best be secured on the other, the plate will be kept in its most reliable condition, *i.e.*, always true.

On the other hand, if cored holes are decided upon, they should always be as *few* and as *small* as is consistent with the dimensions of the work they are intended to support and the machines at which they are to be used.

An angle-plate with surfaces well riddled with holes can be bought cheap enough at a dealer's, but too much accommodation in these appliances may quickly prove to be worse than none, especially to an amateur, whose work is always particular, and whose bolts and tools are small and delicate. The most skillful mechanics will never use an angle-plate without first overhauling it, that is, all burrs are removed and a reliable try-square is applied to the faces; even after the plate is fastened down, a further test for truth will be made. This shows that the plates are sometimes bent by an overstrain, and when this occurs thin strips of paper are used for packing, and the plate secured hard down, and then tried at different points with the square until the plate is true. There are two causes for a bent plate—one, abuse; the other shows a permanent weakness. Obviously, the packing inserted will do the surface no real good, and after a time the surfaces must be re-tooled and made true again.

If matters could remain thus, no further overhaul would be necessary; but, unfortunately, after truing a bent plate, it is made a little thinner, and therefore a little less liable to resist bending. It will now be clear that original plates—to do good service—must be thick and well tied with fillets and webs to keep them accurate.

The great disadvantage of using an angle-plate at the lathe is owing to the increased weight overhanging the spindle nose; the smaller the lathe, the greater this defect is to be seen. It will be noticeable in different ways, the most frequent one being an increased vibration of the whole lathe, especially when the gearing is out of use. Another thing will be the heating of the front bearing, because of the downward pressure on the spindle neck. Journal bearings, being provided with a shoulder fitting each

Conical bearings are so sensitive that an oval bearing will quickly be formed if any slack whatever is allowed at the front end of the spindle cone.

When turning has to be done the horizontal thrust can generally be given a considerable help by placing a drill between the work and the poppet center. Cored work can be similarly treated, or a thin shaft used instead of the drill. Articles to be turned and bored while thus carried on an angle-plate give the best results when bored first, in which case a fitting shaft or mandrel can be inserted. This ensures the work being tooled concentrically, and permits of deeper cuts being taken.

There is still one further suggestion respecting the downward thrust on the

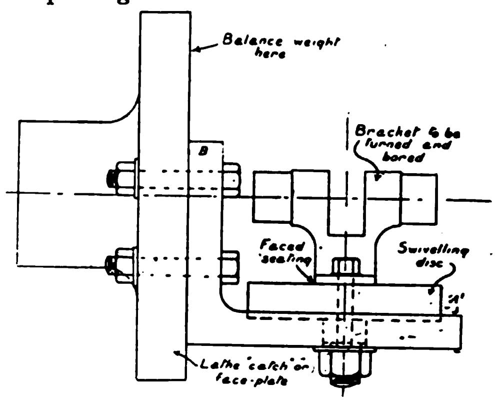


Fig. 3. Showing the Use of the Angle-plate in the Lathe

spindle neck, and that is to place wood blocks in the lathe gap and then drive in a wooden wedge between the blocks and the rim of the faceplate, the lathe being first started, and the rim of the plate oiled before the wedge is inserted.

Now the unfortunate thing is that small lathes are ever provided with gap-beds, the gap being bridged over by a satisfactory plate, which can be secured so that the bed becomes as rigid as one made solid. It is, however, when the gap is open that the trouble may commence; the saddle is robbed of an important part of its support just at the time when it is most needed—that is, when overhanging work has to be tooled while riding on an angle-plate or other

that faces A and $A1$ are tooled parallel to each other and at right angles to B, and that by fixing the work on the table $A1$ instead of the face A, the face B can be turned inwards towards the center of the faceplate. By this alteration the advantages are threefold—more room for bolts, little or no overhang (therefore, less wear and vibration), and the bed bridge kept intact. Compare Figs. 3 and 6, which represent a piece of work from the same pattern.

The above points should be sufficiently conclusive to warrant the adoption of this method by all readers who have small lathes and who have been content to use one angle-plate for all purposes, such a plate being dressed only on its adjacent sides.

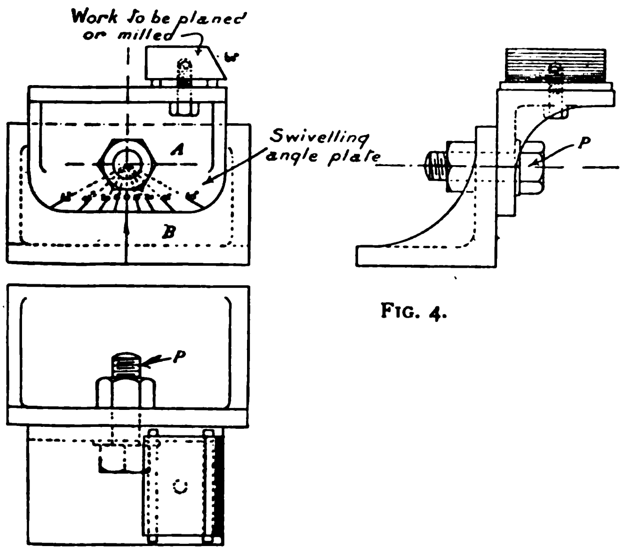


FIG. 4.

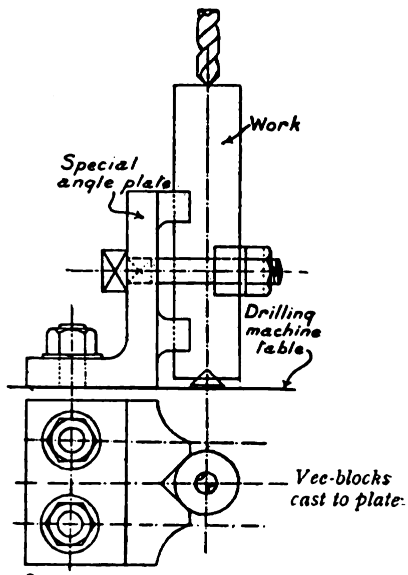


FIG. 5.

In works where it is the practice to manufacture a specialty, such, for instance, as brass valves and cocks, then special angle-plates are necessary. The pattern for the plate is designed to carry one particular piece of work, in which case the plate is converted into a "holding jig," and the castings are simply placed on the jigplate and are self-set, needing only to be clamped down.

Another form of angle-plate is shown in Fig. 4, which is really a combination of two plates fitted face to face, one of which is capable of swivelling on a turned pin P. It will be seen that the face of the plate A is divided into degrees of a circle and the plate B fitted with an indicator. By this arrangement the exact position of any surface can be determined and any desired angle obtained with precision without the necessity of first marking out the work, as is the case in the ordinary way of working. Two plates used in this way considerably facilitate the output in some classes of work. Take the example illustrated in Fig. 4, which represents a "strip" for a machine slide, which requires tooling on each of the four faces. There will be two "settings" of the work instead of three, because the angular surface can be swivelled into the horizontal plane, and there treated without altering the cutting tool. While for amateur milling—where it is practised—slab cutters can generally be utilized, instead of purchasing special cutters for angular work. Readers who may not have the convenience of an accurately divided wheel can get the angle-plate done, *i.e.*, graduated, at any reliable tool-makers, or, if they choose to dispense with the indications, they will have to mark out their work first and then use the swivelling-plate, locking it in position, as shown, and testing by the use of a surface gauge on each surface to be tooled.

The above combination of plates is equally useful at the drilling machine whenever holes are to be made at an angle, either to each other or to any given surface. By having radial slots suitably

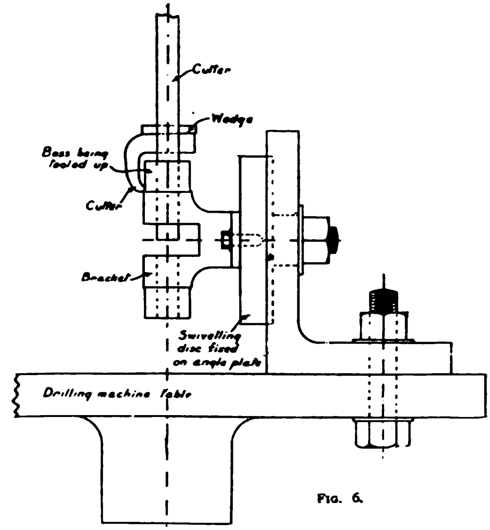


FIG. 6.

placed in each plate, and a bolt placed on either side of the center-pin, ample support is given for almost any class of work.

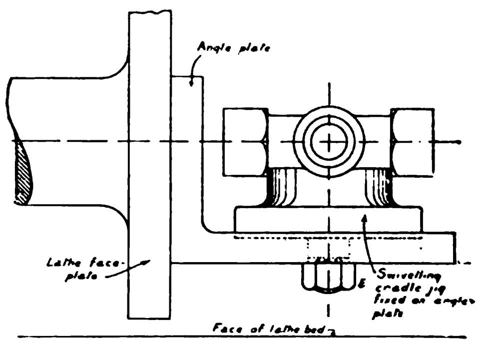
There are many pieces of work which could be accomplished at the drilling machine quite satisfactorily if "special angle-plates" could be used. This, of course, could not be considered for single jobs, but where examples recur they should always be considered.

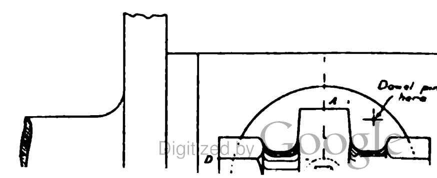
A simple case is to bore or drill a deep hole in a cylindrical shaft. Ordinarily, this would be mounted in a "self-centering chuck," or a "bell chuck" in the lathe, while the outer end of the shaft would require a "stay" or "boring collar stay" to support it. An ordinary angle-plate could be used and a pair of V-blocks taken from the marking-out table; but when a number of these shafts require drilling, then it is advisable to cast a pair of V-blocks to an angle-plate, and, after planing, shaping, or milling up the surfaces, the plate is ready for use with just a bolt and a clip with which to secure the shaft in place without setting. This arrangement is shown with a shaft ready for drilling in Fig. 5. It will be seen that the extremity of the shaft stands on a center point; this is to ensure the shaft's being properly located axially in

work: the bracket would be mounted upon an angle-plate after the base had been tooled either by shaping or milling, and the holes drilled, bored, and reamed. Afterwards the bracket would be fitted with a mandrel and mounted on the lathe centers, each boss being tooled in turn. Now by using an angle-plate in the way illustrated, all the tooling can be accomplished at a drilling machine quite satisfactorily.

If the brackets are to be anything less than ¾ in. bore they can be more reliably tooled when the bosses are cast solid; the drills can also be run at a much higher speed and with less damaging effects.

In this case the angle-plate is fitted with an indicated disc controlled by a "central pin" and "dowel pin" for further security. The angle-plate proper is bored for the pin and counterbored a little to receive the disc. The drawing is simple, and should fully explain the arrangement. It is by this principle, in which boring bars taking a bearing in the machine table, that drilling machines can compare favorably with lathes on many jobs of a similar kind. (See also Fig. 3.) Of course, the angle-plate in all work of the above character remains





in a permanent position until all work of a given pattern has been executed, for by so doing the original dimensions are accurately repeated in each example without any possibility of error; the appliance, therefore, resolves itself into a "jig," illustrating a method of working now fast becoming universal.

It will be seen that the same appliance could be used at the lathe without alteration, but nothing would be gained unless a turret carrying all the required tools were employed; then, of course, the lathe would surely make a decided gain, because it would be much more easily manipulated.

An angle-plate of a special character is given in Fig. 7, illustrating a piece of work to be tooled on four faces without removal when once properly set. The example given has to be bored and screw-cut on the two opposite ends *BD*, while *CA* has to be bored taper and faced at each end.

The disc is accurately divided into four, and these four lines are made to agree in turn with an index mark on the face at the front of the angle-plate. Of course, one angle-plate will answer for a considerable number of different discs; but each disc, being specially designed to fit a certain form of casting, can be quickly changed, as required.

To ensure the work's remaining in one position after fixing in the jig, a clip made of the same contour is placed above the work. This has to be very carefully adjusted in the first instance, but when once properly made to coincide no possible movement can be given to the work during tooling operations. Tools carried in a turret may each take their respective turn, and thus reduce the time, the skill, and the cost to a minimum, points of growing importance in work of a repetitionary character.—*The Model Engineer and Electrician.*

PROF. FESSENDEN ADDRESSES THE NEW ENGLAND WIRELESS SOCIETY

One of the most interesting talks of the series being given under the direction of the New England Wireless Society, was given Saturday evening, February 1, at Boston, Mass., by Prof. Fessenden. The speaker did not confine himself to any one particular subject, but pleased the audience by exhibiting with the aid of a stereopticon, a large number of photographs of actual apparatus that he had designed. Each photograph was accompanied with a detailed explanation. These explanations contained so much valuable information that it is worth while to enumerate some of them here.

The first series of photographs were of gaps used for the production of high-frequency alternations. Various types of gaps from the earliest experimental forms to the one now being used at the 100 k.w. Arlington station were shown and explained. In this series were the gaps used for radio-telephony. The conclusion arrived at by Prof. Fessenden is that for radio-telephony the most satisfactory gap now employed is the water-cooled arc, and one which does not use hydrogen. The hydrogen appears to have a too high resistance to be of good service in such arcs. In connection with the arcs, several other photographs pertaining to radio-telephony were exhibited. Among these was the loud-speaking transmitter. Experiments have shown that not a group of transmitters, but one effectively cooled transmitter is best for such work. In connection with this point a discussion arose as to the limitations of such a transmitter, and the final decision appeared to be that since a properly designed transmitter should absorb energy equal to that radiated by the antenna, the limitation comes at about ½ k.w. of radiated energy. Just how far this consumption of energy can be increased the speaker did not commit himself, but he did favor his listeners by giving and explaining diagrams whereby it is possible to overcome many of the difficulties of radio-telephony. This part of the talk was concluded by showing several photographs of the gap now employed at the new government station at Arlington, Va. This gap is very efficient and the photographs of the gap in operation with the casing removed showed how effectively the spark was kept at the electrodes instead of arcing before and after the proper time of discharge. The brilliant effects produced by this spark on discharge resemble those produced by a brilliant arc lamp.

The next part of the talk concerned

high-frequency alternators. The discussion of this subject was particularly interesting. The various types, from some of the early ones having 10 in. rotors to the later ones with 30 in. rotors, were shown. The great difficulty with these machines is that owing to the fact that since they run with a peripheral speed of as high as 12½ miles per minute, they must have a very rigid mechanical construction, and they must be kept very carefully oiled. These alternators have been constructed with a frequency as high as 50,000 cycles when run at 35 k.w. by a De Laval turbine The highest frequencies that have been very successfully obtained for work of this sort is 200,000 cycles per second. The efficiency of these alternators has repeatedly shown itself to be higher than the commercial 60-cycle alternators. In connection with these alternators the non-tuned system of radio-telegraphy, in which the hetradyne receivers are used, was explained. Prof. Fessenden called attention to the fact that this system has an efficiency of about one hundred times that of the crystal rectifiers.

The last series of photographs were of the old Brant Rock, Mass., the Scotland, and the new Arlington, Va., stations. These were especially interesting because of the trials now being conducted by the government on the latter station. The type of poles used at the Brant Rock and at the Scotland stations caused considerable comment. These poles are 425 ft. high and are constructed of hollow steel tubes varying from 3/16 to 5/16 in. in thickness. It was necessary to design these poles for wind pressures of 125 miles per hour and to withstand 500,000 volts without leaking. In order to keep the pole from bending under the high wind stresses, it is pivoted at the bottom so that it will bend as a unit, and in that way will not develop any undue fiber stresses. Glazed porcelain insulators are used. Special features are employed to overcome any unequal electrical stresses, thus protecting the insulators from being chipped by spark discharges. After explaining the pole construction, photographs of the apparatus then at Brant Rock, but now at the Arlington station, were shown. At the Arlington station three towers, the tallest of which is 600 ft., take the place of the single pole. The special features, such as the air condensers with plates but ⅛ in. apart, and the automatic break for the 100 k.w., were also described. This station is able to work with an efficiency of as high as 80 per cent.

After the formal talk by Prof. Fessenden, an informal discussion took place. Many new points in radio-telegraphy are brought out in these discussions, for the most prominent men interested in wireless in New England take part in them. At this meeting Mr. G. W. Pickard, the radio-inspector for New England, government officers from the Charlestown Navy Yard, and many others including representatives of the Marconi and other commercial companies presented very interesting points. In conclusion Prof. Fessenden commented of the very large audience present, and he suggested that the science of radio-telegraphy must be making very rapid strides in order to stir up so much enthusiasm. The society is composed of members from the various colleges and scientific institutions of New England, and of commercial and experimental men at large. Any information regarding the society may be had by addressing the Secretary, Mr. E. W. Chapen, 43 Thayer Hall, Cambridge, Mass. The meetings are held in or near Boston, Mass., the first Saturday of each month. Any person not a member of the society may attend these meetings on the invitation of a member or by addressing the Secretary. All persons interested in wireless are cordially welcome.

Union Pacific Wireless Line.

RAILWAY APPLIES FOR FEDERAL LICENSE FOR CONSTRUCTION OF EXPERIMENT STATION

OMAHA, NEB., December 24.—The Union Pacific Railway has made application to the Department of Commerce and Labor at Washington for a license to operate and maintain a wireless telegraph system along its lines. The company wishes to install a technical experiment station and the Government is requested to give permission for such a station, which, it is stated, will be the second of the kind in the country. Several wireless stations, it is announced, will be constructed when the license is issued.

A HIGH VOLTAGE INSULATION TESTING OUTFIT

CHAS. F. FRAASA, JR.

Insulation tests are very common in every electrical shop, yet very few are prepared with suitable apparatus to make the most satisfactory test. For most ground tests, a voltage of from 500 to 1,500 volts will be satisfactory. The highest pressure usually obtainable is about 110 volts alternating. Some means of raising the voltage to the desired pressure should be employed. This is accomplished by means of the step-up transformer, taking 60-cycle alternating current at 110 volts, and transforming it to from 500 to 1,500 volts. The design given in this article is used by a large electrical manufacturing company for testing for grounds or leaks in armatures, field magnets, controllers, etc., several being provided in its different departments.

The complete outfit consists of a step-up transformer, providing the high voltage, a switchboard, and two test leads. The switchboard, Figs. 1 and 2, provides the necessary connections or the apparatus, and a mounting for the transformer and switches. The fuse *A* is in the primary circuit of the transformer. The pilot lamp *B* is used to show when there

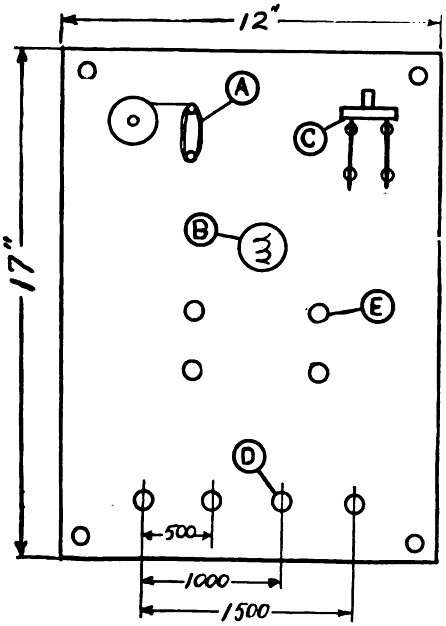


Fig. 1—Switchboard

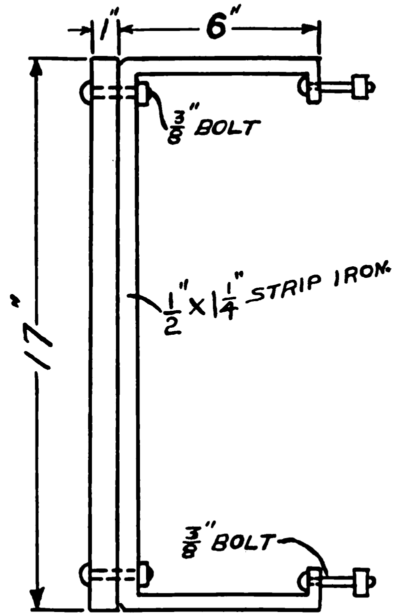


Fig. 2—Switchboard

is current in the primary. The switch *C* is in the primary circuit, and the plug holes *D*, which provide taps of 500, 1,000 and 1,500 volts, are in the secondary circuit. The transformer, illustrated in Fig. 3, is mounted on the back of the switchboard by means of the bolts *E*, Fig. 1, connections being made by wiring on the back of the board.

The transformer is of the step-up, shell type, and steps up 110 volts alternating current of 60 cycles to a pressure of 1,500 volts. Taps are provided to obtain 500, 1,000 and 1,500 volts for testing. The general appearance of the finished transformer is shown in Fig. 3. For convenience in assembling the core around the coils, it was designed to be made in plain, straight strips. This also has the advantage of requiring no special punchings, since the plain strips can readily be cut up on an ordinary tinner's squaring shears. The various parts, of which there are four sizes, are lettered *A*, *B*, *C* and *D*, Fig. 4, which shows the core construction. Alternate layers are laid in this way. Those coming between are just the reverse. These parts are

dimensioned in Fig. 5, the letters on the different strips referring to Fig. 4.

The transformer core is cut from some No. 27 gauge sheet iron. Enough of the *A* and *B* strips should be cut to make a stack of each 2 in. thick, and of the *C* and *D* strips to make a stack of each 4 in. thick. To cut down the heating due to eddy currents in the core, the core sheets should be insulated from one another. This may be done by shellacking one side of each strip or by dipping alternate strips in shellac. Assemble the *A* pieces as in Fig. 6, laying the strips so that they alternately lap first on one end and then on the other, for a distance of 1 in.

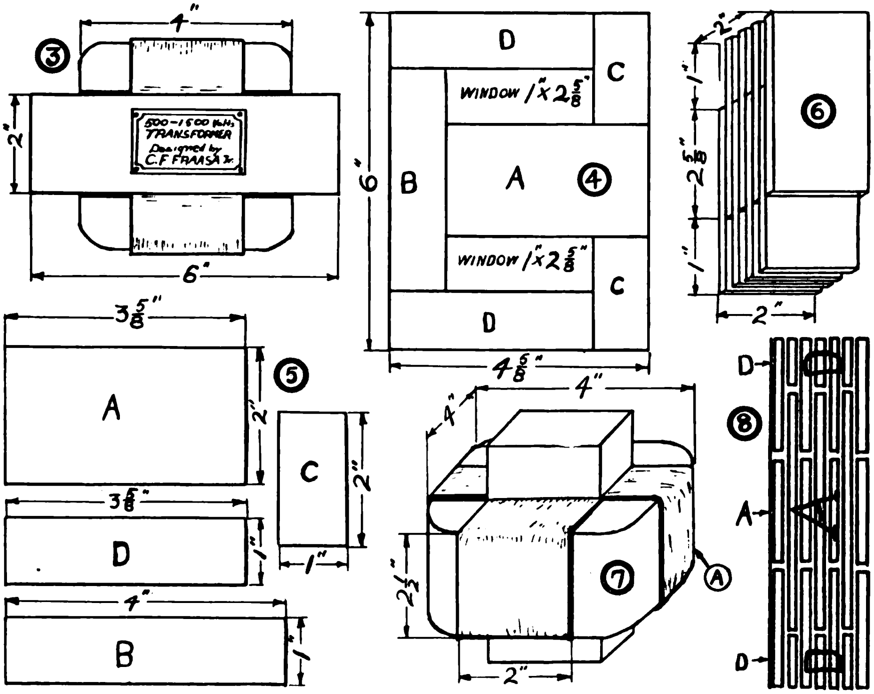
When the *A* strips have been assembled, wrap a layer or two of friction tape around the solid center portion, to bind the strips together. To insulate the core from the primary, wind on two layers of manila paper and one of twine, and apply a liberal coat of shellac.

Get two pieces of 7/8 in. wood, and cut a

1/32 in. thick, and bend the ends back over the blocks. The core is then ready to receive the windings.

The customary practice is to wind the secondary coil directly over the core, and under the primary, to obtain good regulation. In this transformer the secondary will be wound outside the primary for convenience in making the taps, and to prevent undue currents when the secondary is short circuited through a ground.

The primary winding, consisting of 345 turns of No. 21 d.c.c. magnet wire, should then be wound on evenly and in layers between the end blocks. As the the winding proceeds, interpose layers of



paper, and when completed, wind on one or two layers of duck, and over this a layer of twine, then shellac the whole, using at least two coats. Then wind on the secondary of 5,175 turns of No. 34 enameled wire. Be careful to wind this on evenly, and in layers. This secondary winding should be most carefully handled

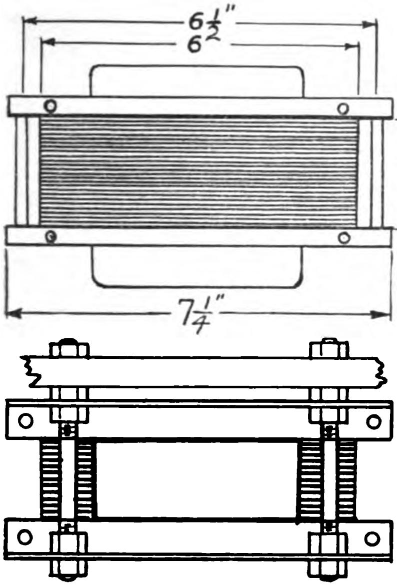


Fig. 9—Transformer Detail

coil. Over the whole coil, and the fiber strips, wind a protecting layer or two of heavy duck, filling each layer heavily with shellac.

On the 1,725 turn, bring out the first tap for 500 volts; on the 3,450 turn, the second tap for 1,000 volts. These taps should have a short piece of lamp cord soldered to them for the connections to the plugs on the switchboard.

The *D* pieces should then be assembled as were the *A* pieces, and the loose sheets bound together with tape. Set the *A* core up on end, and insert the *B* pieces in the open spaces in the end of the core, letting the ends of the strips project 1 in. on each side of the core. Then set one *D* core on each side of the *A* core, touching the *B* strips. Fill in the spaces in the *D* cores and in between the *B* strips with the *C* strips. Fig. 8 shows a top view of the assembled core, and shows how the various pieces are placed.

The core is clamped together by the angle irons shown in Fig. 9. The 5/16 in. bolts which hold the angle irons together are long enough to extend through the mounting board, providing a means of mounting the transformer. The illustration shows clearly how the transformer is mounted, and dimensions the angle irons.

The switchboard, Figs. 1 and 2, may be made of slate, marble, or any insulating substance that may be available. It should be about 1 in. thick. At the top of the board, provide three brass rods to hold the fuse spool and the fuse. The two rods holding the fuse are 1½ in. apart. Provide a lamp socket at *B* for an 8 c.p. incandescent lamp, which is wired in parallel with the transformer primary. This is used to indicate a current in the primary. The switch *C* is an ordinary double-pole single-throw knife switch, having the upper clips connected to the 110-volt line; and the pilot lamp and the transformer connected in parallel to the lower clips. The four holes *D* are provided for the secondary plug switch.

The construction of the plug switch is illustrated in Fig. 10. The plug *A* consists of a hard wooden handle *D* turned to the shape shown, and a brass

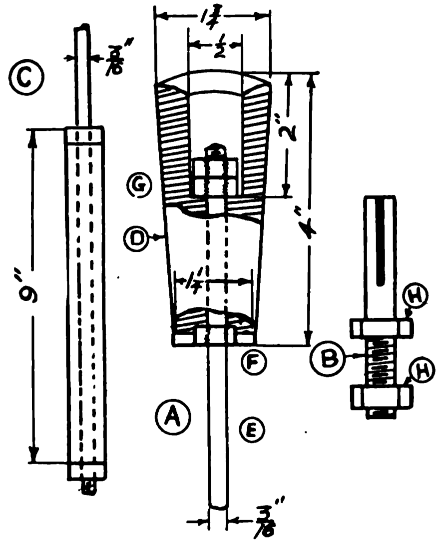


Fig. 10

rod *E* fastened into the handle by the nuts *F* and *G*. A piece of flexible cord is connected to the end of the brass rod in the handle. The switch socket construction is detailed in the same figure, at *B*. A piece of brass tube having an internal diameter slightly larger than the diameter of the brass rod in the plug has one end threaded to receive the two nuts *H* which fix it in the holes provided in the board. The other end of the tube has two slots sawed in it at right angles to one another. The four prongs of the tube are then lightly driven together with a hammer. When the plug is inserted the four parts of the tube will bind it

(*Continued on page* 159)

A RAILWAY IN THE AIR

S. A. JAMES

Grade difficulties in connection with transport are sufficiently well known to engineers to make it unnecessary to dilate on the difficulties encountered. These are enhanced when instead of the grounds being fairly level, a steep incline has to be encountered and the problem of transport either of goods or passengers up heavy inclines such as a mountain side of irregular formation are very great indeed. The simplest method is to raise the whole railway above the level of the irregularities, but this is easier said than

Fig. 1

done, and it is very largely owing to the enterprise of the firm of Messrs. Adolph Bleichert & Co., of Leipzig and London, that the modern system of transport by means of aerial cables has been developed. A very remarkable instance of this class of work is found in a railway which has illustration of this railway which incidentally gives some idea of the tremendous grades which are encountered. The cars, which are suspended from steel cables, are as comfortable as a modern tramcar of small size, and travel in a smooth and easy manner along steel suspension cables, the total length of which is 1,650 meters, and which are carried by twelve structural steel supports of the form shown in the figure. Each car is capable of holding fifteen passengers and the driver, and two cars travel simultaneously each way at one time. The speed is such that in thirteen minutes a difference of level of 840 meters is secured, each car being pulled by two traction cables which receive their motion from a power station placed close to the line. The object of duplicating the cables is to secure safety in case of the breakdown of one of the cables, and the same means is adopted in connection with the suspension cables. Each car is supported from a traveling mechanism carried by eight pulleys; each of the steel cables on which these pulleys rest being 44 millimetres in diameter. The car can swing like a pendulum, a brake retarding any undue oscillation; while any fear of derailment due to oscillation sideways is avoided by the fact that the carrying cables themselves swing with the car. The drive is electrical, and in order to secure immunity from breakdown of the transmission system even if the power plant fails to operate, a buffer battery is installed which operates in parallel with the dynamos. In order to effect communication, a system of telephones and electric signals is installed throughout the track, and the driver from any part of the line can communicate with either the upper or lower terminal station. The cars cannot be started before the necessary signals have been given between the two stations and confirmed so that there is no danger of mistake. In addition to this, safety is most efficiently studied in connection with every detail of the equipment. The traveling mechanism of the car contains

cable breaks or if a fracture occurs on either one or both of the hauling cables. Moreover, the driver can put his brakes into action by hand, the operation being simple and quick. When this catching device is put into action steel jaws grip the carrying cables at eight different places, the friction being sufficient to hold the car firmly in position even on an incline. Simultaneously, by the movement of the same mechanism, the supply of electricity to the driving motor is stopped and the brake is instantly applied.

In order further to secure the safety of the passengers in the event of a breakdown, a spare car is kept at each station in readiness to go to the point where the ordinary car is left suspended and transfer the passengers and bring them back to the nearest available station, while the ordinary car is also fitted with a special device in the floor by means of which it is possible to lower the passengers to the ground from the car direct, this hoist being fitted with a brake to prevent undue speed of descent. Should the driving gear of the whole line break down, thus stranding the cars in the middle of their route, an auxiliary winder is available for bringing the cars back to their terminal position. It will, therefore, be seen that this novel and interesting application of electric traction has been carefully thought out and designed in all its details in order to secure safety and reliability of service, and it is apparent that in this aerial system of transmission a great number of difficulties have been avoided which would otherwise have been encountered in proceeding over such a rough and mountainous section of route.

SMALL CASE-HARDENING FURNACE

OWEN LINLEY

The following is a makeshift furnace that I used some years ago in the early days of motor-cars for hardening gears, etc., and it gave good results, and wanted but little attention. Lay a circle of bricks on the floor, if it is of earth or brick. The bricks should be laid on their flats, with a space of 3 in. between the ends, and on this circle lay another one just similar, the bricks of which go over the openings of the first, and continue this until the required height is obtained. Do not build the furnace on a grating, with the idea of getting a draught, as this is inclined to make the bottom of the pot hotter than the rest, which is bad for the work. The best way to light a fire in the bottom of the furnace is to make some coal or coke hot in a forge, if one is at hand, and put it in the bottom of the fireplace, and it will start other fuel that is put on it. Between the openings of the bricks put some irons to support the pot, and this should be three bricks from the ground. Fill the furnace up with coke until the pot is covered, and let the fire burn. No artificial draught is wanted, and this is the advantage of this arrangement, as it is thus almost impossible to overheat the pot, and if the fireplace than the other, it is easily damped on the side required by closing the gaps between the ends of the bricks with earth or ashes. It wants hardly any attention otherwise. We used to let the pots get just fairly red-hot, and keep them so for from four to six hours, and mostly put a test-piece in, which we hardened and broke, so as to show the depth of the skin.

A High Voltage Insulation Testing Outfit

(*Concluded from page* 157)

tightly and make contact. The taps from the transformer are connected to the brass tube and soldered between the two nuts. The test leads are dimensioned in Fig. 10, *C*. They consist of two long fiber tubes through which run a 3/16 in. brass or copper rod. The fiber tube is kept in place by means of a nut at each end of the rod. These leads are connected and soldered to the ends of the flexible conductor running from the plugs *A*.

The plugs are inserted in the sockets giving the proper testing voltage, and the switch *C*, Fig. 1, is thrown up. The lamp will then light up, indicating a current in the primary circuit. The fuse *A* should be 1 ampere fuse, and several

FIRST TALK OVER THE TELEPHONE

It seems almost incredible that ten days should elapse between the first conversation ever carried on by word of mouth over a wire and the announcement of it in the newspapers of the day. *New England Telephone Topics* says that, however, was the fact away back in October, 1876, when Professor Bell used the telegraph line owned by the Walworth Manufacturing Company, extending from their office in Kilby St., Boston, to their factory in Cambridgeport, a distance of about two miles, for the first telephonic conversation in history.

The night before this successful experiment took place Professor Bell asked the night watchman of the Walworth Building whether he could use that telegraph wire. The watchman told Professor Bell that he would inquire of the head of the firm and let the professor know the next morning whether the privilege would be granted. Professor Bell called at the office and was given permission, the group surrounding him jeering at his "play toy," and wondering what crazy notions he had in his head.

One of the officers of the Walworth Company recently told the writer that Mr. Bell had a considerable bill with the Walworth Manufacturing Company in 1876, and that he several times offered to pay the bill in telephone stock. On the morning when Professor Bell received permission to use the telegraph wire he again offered enough stock at twenty-five cents per share to pay the bill, but the offer was scorned.

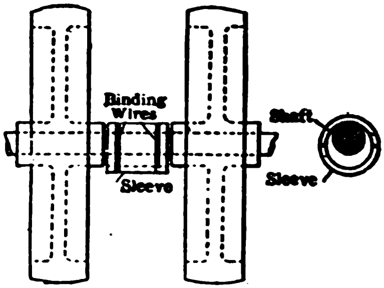
The experiment took place on the evening of October 9, 1876, between Professor Bell and Thomas A. Watson, the latter being located at the Cambridge end of the wire. Each at his respective post took notes of what was said and heard, and a comparison of the two records is most interesting as showing the accuracy of what was then called the "electrical transmission" of their conversation.

This experiment proved so successful. Professor Bell was told that his stock was going up too fast and the offer was not accepted.

On Thursday morning, October 19, the Boston *Daily Advertiser* printed an account of the experiment. The article was headed: "Telephony—Audible Speech Conveyed Two Miles by Telegraph. Professor A. Graham Bell's Discovery. Successful and Interesting Experiment. A Record of the Conversation Carried on Between Boston and Cambridgeport." The article states that the "company's battery consisting of nine Daniel's cells was removed from the circuit and another of ten carbon elements substituted. Articulate conversation then took place through the wire. The sounds, at first faint and indistinct, became suddenly quite loud and intelligent."

To Save Belt Wear

A writer to the *American Machinist* gives the following hint for avoiding the undesirability of an idle belt hanging loose on a revolving shaft. Take two



wood bushings a little larger than the shaft, and bind them on with soft wire at the place where the belt will rest when idle. The sketch herewith shows the device.

She Meant Well

He—"The last time I played football

MAKING BRASS BEARINGS

"SREGOR"

The accompanying sketches show methods of machining accurately the common form of engine and general machine bearings. Most readers who have attempted to make this plain bearing on accurate lines, and to produce same quickly, no doubt have realized the difficulty of ensuring the joint face's being exactly in the center of the two halves of the brass, the necessity of this accuracy depending upon the general design of the machine or parts

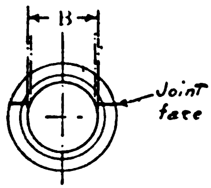


Fig. 1

into which the bearing fits. But, theoretically speaking, the joint face should be at the center of the two halves, from the fact that when one half is less than the other (as shown in Fig. 1, exaggerated) it cannot receive the journal *B* it is intended for; but a reasonable amount of difference is not very noticeable, as the bearing is usually scraped away each side of the joint face to provide a clearance

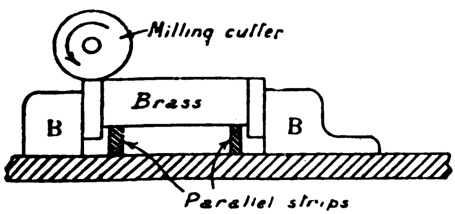


Fig. 2

for oil. But to ensure accuracy, say to two or three thousandths of an inch, special provision must be provided. The first thing to determine is the amount of metal there is to remove from the casting

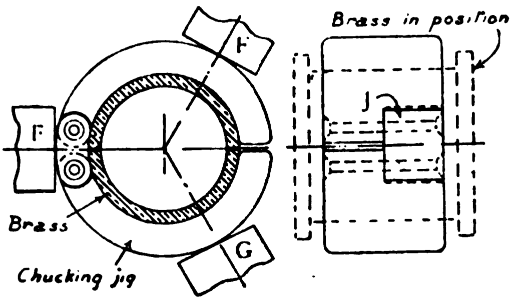
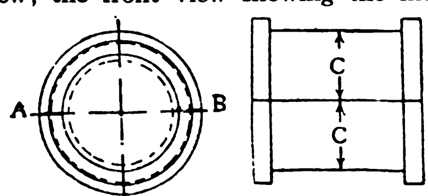


Fig. 3—Front and Side Elevation

ter is once set, any number of castings can be milled to the same size (allowing, of course, when necessary to grind cutter). Having milled the joint faces, they are ready for the first operation on the lathe. A very suitable method of chucking these is to provide a split ring hinged at one side (as shown in Fig. 3). The more common practice is to hold the one flange in the chuck and fix a cramp on the other; but owing to the small amount of grip available on the narrow flange and the distance the opposite end projects from chuck, it is impracticable to take a heavy cut. The split ring overcomes these difficulties; the brass being firmly gripped in the center and the diameter of ring securely held in a three-jaw self-centering chuck, with one side of the ring pressed against the chuck jaws, which should ensure the joint faces of the brass running true. This arrangement is shown in Fig. 3, a front and side view; the front view showing the most



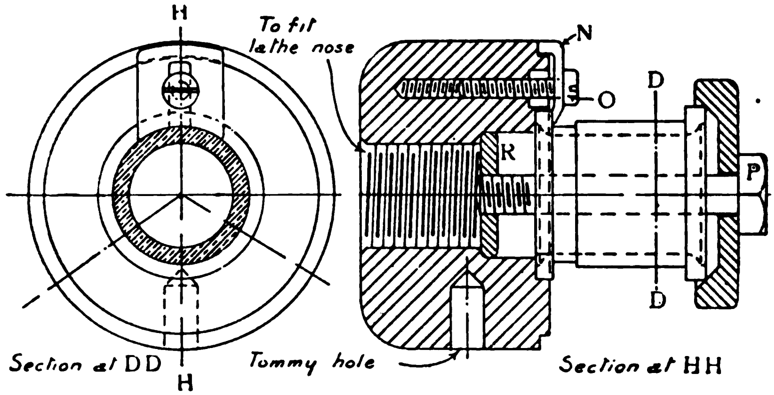


Fig. 6

suitable position for the chuck ring to be held in the jaws to equalize the pressure from same. The idea of the chuck ring's being hinged is to keep the two halves together, being thus much more convenient to handle, as shown. The ring is split through the center and a portion of one side is shaped away to receive the hinge block *J*. The brass can now be bored and one side of the flange faced and a radius formed, if the design of brass is as shown in Fig. 4; also the diameter of the flange must be turned to finished size which completes the first lathe operation.

The chuck jaws should now be eased back and the ring and brass reversed in the jaws, taking care that the brasses do not move when changing the position, and again pressing the back of chuck ring hard against lathe chuck jaws to ensure running true. The other flange, face, and diameter can now be turned, and the radius formed, if necessary. The last operation is accomplished by fixing the brasses on the mandrel (as shown in Fig. 5), which consists of the center-piece *BB*, which is turned to clear the bore slightly. The two flanges serve to hold the two halves of brass true and tight together under the pressure of the nut *C*, when the center part of brass can be readily turned to size with the mandrel between the centers in the usual way. The angle part of the flanges readily center the brasses by locating on the edges of the already turned flanges. The adjustable loose sleeve *D* should be a nice sliding fit on the mandrel, and designed with a long bearing, as shown, to eliminate any possibility of the face of flange tipping out of the true position.

Another method, and one which is more applicable to the ordinary capstan, and dispenses with the necessity of the lathe centers, is that shown in Fig. 6, which illustrates a plain cast-iron casting of suitable size, and bored and screwed to fit the capstan nose, after which it is recessed as shown, to receive the turned flange of the brass after the first operation, Fig. 7. The diameter is also reduced to a distance (as shown in Fig. 6), to receive the holding-down clip *N*; these clips are slotted with an open end, so that they can readily be slipped on and off the set pins *O*. The three holes are drilled and tapped equidistant around the face for the clips; the outer end of these holes are recessed to receive the pin heads, so that they may be readily screwed in out of the way for the next operation. The arrangement, as shown, can be used for facing the one end flange and turning

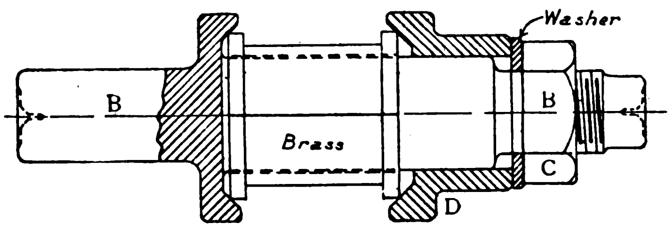


Fig. 5

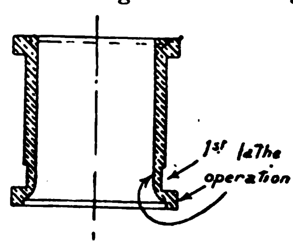
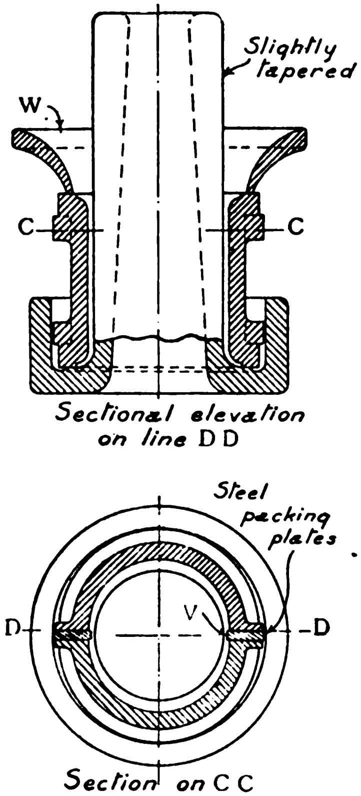


Fig. 7



Jig for White Metalling Bearings

Fig. 9

diameter of same, and forming the radius as the second operation on the brass, as shown in Fig. 6. The clips serve to hold the two halves of brass in position in the recess during the operation of turning the opposite end flange, after which the end plate, which is similar to that shown on the mandrel, Fig. 5, is held against the flange with the bolt *D*, which screws into the piece *R*, which must be secured in position. The plate or clip *N* can now be released and the pins *O* screwed into the casting out of the way and the center part finished and turned, which completes the brass.

The three views shown in Fig. 4 are the outline of the finished brass. The sectional plan shows a liner of white metal in the bore. I shall show farther on a suitable design for a mold for running the metal into position on the brass, and method of machining same to ensure even thickness of metal, etc.

The following description is intended to illustrate method of producing bearings, either if used as a plain brass or white metal surface, and to be on absolute interchangeable accuracy. Of course what is inferred by accuracy in the case of this article is meant that whichever method is used will guarantee the ordinary degree of accuracy, that is, so that the bore shall be a true, round, and parallel hole, and the outer diameters shall be concentric with same; and whether the joint face is exactly central and parallel with bore does not make any material difference as regards the function of the bearing. But in the event of attempting to produce each half of the bearing exactly the same, and to guarantee interchangeability, the joint face obviously must be exactly central to the two pieces. Most up-to-date engine manufacturers will attempt to obtain this accuracy, and it is the object of this article to illustrate how the writer has obtained the desired end. It will be observed, from the illustrations previously shown, that the method there described provides for ordinary accuracy combined with cheap production. The points of difference between that method and the one described in the following lines are: The fact that the castings of the brasses are provided with special locating pieces, as shown in Fig. 8. It will be observed that the width of these pieces is greater

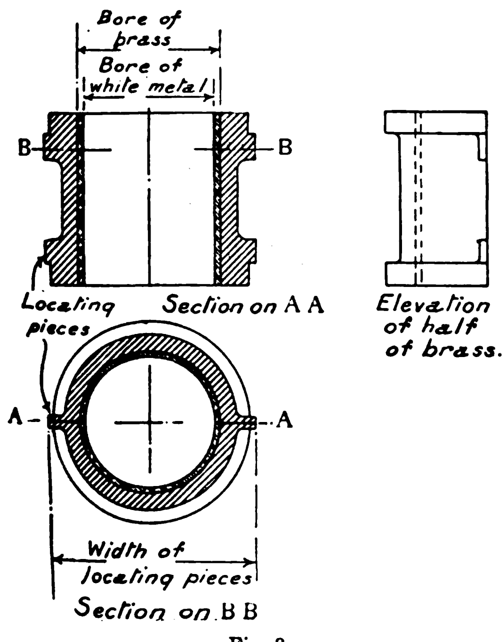


Fig. 8

than the diameter of the flanges of the brass. The object of this is to provide a definite interchangeable width, to locate and fit the jig into which it fits for the turning operations. The second point of difference is the design of the jig for boring and turning. As shown in illustration, Fig. 10, this consists of the angle plates *L*, which locate on the plug *M*, which, of course, is turned to size in position, to guarantee running true. While mentioning this plug, I would suggest that this should be made a definite decimal standard size, say 1 in., to fit a standard 1-in. reamered hole, from the fact that, knowing the exact size, it will be useful for gauging purposes for other operations, not particularly applicable in this article. Continuing the parts ter. It will be observed that only the one-half brass has the locating piece cast on.

The operations on the brasses are as follows, and a difference of processes between this and that described previously is: The brasses are made and used as a brass bearing in the previous pages, but in this it is the intention to show how to produce the two halves as a white metal bearing. The advantage of the latter type as a bearing is in the virtue of the white metal, an alloy which, in the writer's experience, is second to none as a high-speed bearing which can readily be renewed when worn. Again, the cost of the two classes of brass that may be used will differ considerably. A good mixture should be used in the former class, whereas a comparatively soft cheap

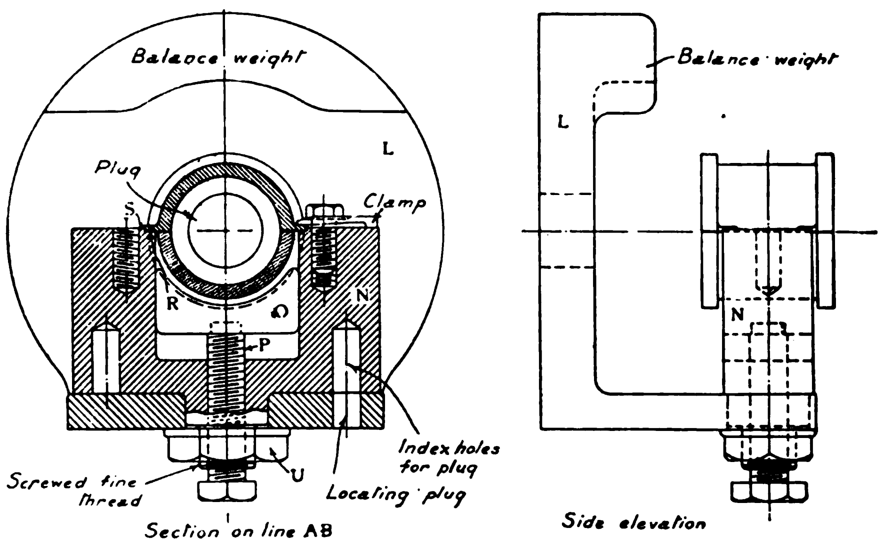


Fig. 10

of the jig, upon the angle plate is mounted the reversible block *N*, into which one half of the complete brass is located. The other half brass is held in position by the block *O* and screw *P*. The reversible block *N* is provided with a hole, which must be absolutely in alignment with center of lathe. These are used for indexing the block when reversing to operate on the opposite end of the work when in position in the jig. Obviously, the two flat faces *R* must be exactly in line with the center of the lathe, otherwise the bore of the two brasses will not be equal depth from the joint face. Also the two side locating faces *S* must be equal distances from lathe center.

material can be used in the latter, ensuring cheapness and rapid manufacture. The machining operation on the white metal bearing in the first cost will be more than the plain brass bearing, but this is well counterbalanced by the advantage of being able to renew the metal in the old bearing when repairing. I shall show an addition to the jig, shown in Fig. 10, to deal effectively with the remetalling and boring of the repair bearings to ensure accuracy later in the article.

The operations for the white metal bearing here described are: Facing the joint faces with the milling cutters, as described previously for the plain brass, with the addition of two side-facing

cutters to clean up the sides of the locating pieces, which ensures all brasses will be exactly same width, and snugly fit the jigs. This is accomplished at one cut. The other half of the brass receives a cut over the joint face. The pair of brasses are now located in the turning and boring jig as shown in Fig. 10, the locating half being secured by the two straps *T*, while the other half is held tight against the other by the saddle piece *O*, and the fine threaded screw *P*. Referring to the plan view, Fig. 11, it will be seen that the two flanges of bearing overlap the jig, which provides for these being turned at the same setting as for boring. Having secured the brasses in position, the bore can be machined, and when used for white metal it should be a coarse traverse and a rough finish; also the outer flange can be turned to size and the end faced, after which the nut *U* is slackened slightly, and the locating plug removed, when the reversible block can be turned round until the other hole comes in line with the locating plug holes, which give the correct position. This brings the other flange to the front, and this can now be turned to size, and the end of bore radiused, as shown in Fig. 9, if necessary. In the event of the ends of brass being radiused, it is advisable to recess the ends, as shown in Fig. 9, which provides for an even amount of metal at the radiused part, as along the bore. This completes the boring operation. The two halves can be removed from jig, and secured on the special mandrel, as shown previously, and the center part of the bearing finished, which completes the bearing in the event of its being used as a plain brass bearing. But as a white metal surface the bore must be tinned and lined with this metal. A jig is shown in Fig. 9 for this purpose. When a quantity is required to be metalled, a jig, such as shown, will be a great advantage, as it provides for a minimum amount of metal's being used, and ensures a clean job, and protects the joint faces from getting covered with it. The process is to place the bearing in the jig after the rough boring operation. It will be observed that pieces of steel packing are placed between the joint face of the two brasses; this is to provide a space, and the small amount of metal, as shown at *V*, can be readily cut through with a saw. Also the thickness of these two packing

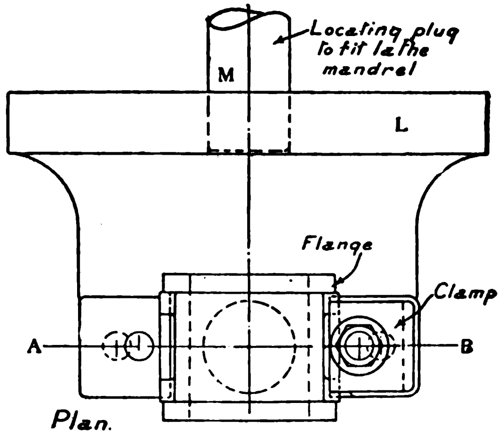


Fig. 11

pieces must be such as to provide that the diameter of the brasses at right angles to the packing will be about equal to the diameter across the locating pads. This gives a definite location in the recess in the jig. The diameter of the bore of jig should be such as to allow the brass to enter easily, after which a plain cramp can be applied against sides of brasses holding the two halves and packing pieces tightly together. The bell-mouth top-piece *W* serves as a receiver for the molten metal, and guides same into the brass. The center portion of jig should be slightly smaller at the top than the bottom, so that it will more readily leave the metal when withdrawing after the brass is lined. The hole in center of jig is intended to receive the Bunsen flame of gas readily to heat the jig, this being the essential part to be hot when running the metal. As soon as the metal is set, and jig cooling down slightly, a blow on the top of jig with a wooden mallet will separate the brasses from the jig, when the two packing pieces can be removed, and the two halves separated, when they are ready to locate again in the turning jig, Fig. 10, to be bored; after which they will be finished on special mandrel same as previously described for the processes on plain bearings. The boring jig must, of course, be provided with at least two holes in back of angle plate at convenient places to bolt jig to lathe face-plate. The jig can readily be removed and accurately refixed by locating on the plug. The jig angle plate is provided with an enlargement to counterbalance the opposite side.—*The Model Engineer and Electrician.*

PERPETUAL MOTION

R. P. HOWGRAVE-GRAHAM, A.M.I.E.E.

Verbal definitions are not always wholly satisfactory, and to state them requires a certain amount of courage when that which is to be defined is in any sense controversial. To gain a clear mental picture of the position, we must stop down our mental lens and get sharp definition in its more abstract sense, even if this involves rather a long exposure.

Perhaps we may fairly start with the following definition:

A perpetual motor is one which will maintain continuous motion for an infinite time by its own perpetual conservation or intrinsic generation of energy, so long as no outside disturbing influence alters the original conditions.

Disturbing influences may reasonably include stoppage through wear of bearings or working parts and rust or general decay. Setting aside these last, it is obvious that if the machine could be isolated in space at a point infinitely far removed from all sources of energy, such as radiating suns, nebulae, or other bodies, it would continue in action for all time.

The first type of perpetual motion device which will be considered involves an attempt at the complete conservation of an initial supply of energy imparted to the mechanism once and for all. Such motion is theoretically possible, but is unattainable by reason of strict limitations of space. If we could reach a point in free and matterless space where gravitational and other forces were either non-existent or equal and opposite in all directions, all frictional or analogous effects being absent, a mass set in rotation about its center of gravity would spin forever, but would only constitute a perpetual motion machine in a very limited sense; no sort of work could be done by it without a corresponding withdrawal of its energy, together with a retardation which would eventually bring it to rest.

Similarly, if a mass were set in motion in space along a straight line, and could travel indefinitely without encountering any extraneous influence, its motion would continue for all time, though here again it could do no work.

By similar principles, orbital motion of one body about another could be maintained if all conceivable tidal, frictional, or electrical retarding action could be annulled. Attempts have been made to attain the necessary conditions by eliminating every energy-loss. A weighted spring vibrating in the highest vacuum obtainable will convert its store of energy into heat by molecular friction in the spring, and by friction with the residual gases.

Even in a perfect vacuum a rotating mass must be supported by some kind of pivot which must cause friction, or by magnetic fields, which cannot be so applied as to avoid loss by hysteresis and eddy-currents. Such devices might move for many days, but could not move perpetually. The motion only exists by virtue of energy stored in the system, or we might say that the energy only exists by virtue of the motion. This apparent contradiction merely means that the energy and motion are co-existent and inter-dependent, so that in providing any opposing force for the system to do work upon, the energy and the motion would be taken from them together, the former being transferred to some other medium or body with or without change of kind. In the case of the weighted spring the energy oscillates between static and dynamic forms.

Once and for all let it be understood that these and other apparently dogmatic statements are based on enunciations known as "laws of Nature," *which have not been found false in any known case up to the present.*

We can be certain of nothing, but knowledge supplemented by common-sense should hold us from the old beaten tracks of fallacious thought, argument and experiment. We must also be guarded in speaking of "all time" and "infinity"—terms involving conceptions which our finite minds can only dimly apprehend.

The second type of machine involves the supposed intrinsic generation of energy by the system itself, usually in sufficient quantity to do useful work in addition to that which is required for the mere maintenance of motion.

Endless are the drawings, patent specifications, articles, and mental activities

which have been and are still wasted in this direction. Among these are arrangements of radial rods hinged in one direction to give greater leverage on one side of the axis of rotation; devices with tubes containing rolling balls, or moving masses of mercury; machines for utilizing the surface tension of liquids; dynamos and motors coupled electrically and mechanically, and countless other inventions. When tried all are soon abandoned, for in all the algebraic sum of the work done by the various portions is zero. In fact, energy cannot be manufactured; it can only be transferred and transmuted, and as in the technical sense energy is the power to do work, it follows that all such machines must be inoperative.

There still remains the third class of machines, in which the energy is drawn from some natural available source, and here one of the correspondents of this paper naively thinks it quite possible that the rising and falling of the barometer (meaning the mercury) could be converted into continuous motion. How modest! Where is the difficulty? When once one admits the idea of tapping Nature's numberless sources of energy, possibilities crowd on one so fast that one scarcely knows where to turn.

But would baro-motors and their like be perpetual motors? In a limited practical sense, yes! In the scientific and real sense, no! The available sources of energy on the earth are none of them permanent, and the terms of their activities are all relative and only differ in degree. A rotting hay-rick might keep some form of heat-engine or thermopile and motor active for months, but it would eventually rot away. Yet to an intelligent colony of microbes in which ripe wisdom gave place to senility and death at the age of two seconds, these motors would seem perpetual.

Niagara Falls, which can supply power continuously to turbines, will exist for thousands of years longer than the rotting hay-rick if no violent geological or celestial disturbances intervene, but they must eventually cease to exist; their energy is part of the accumulated energy which the sun distributes over the surface of the earth, for they are supplied by rainfall resulting from evaporation, which can only take place by absorption of heat energy.

The local variation of the sun's radiant heat could be made to produce sufficient alternate expansion and contraction to keep mechanisms in continuous motion, but the sun will almost certainly grow cold eventually. Tides, again, afford energy which can be stored and used continuously and usefully. Now if we were to take the rick-engine, the turbine, the solar motor, and the tidal machine, to the isolated and uninfluenced spot in space, they would not work, and therefore they would not meet the requirements of our definition.

With regard to radium, the wonderful and epoch-making discoveries in connection with it and kindred substances led to very wild and unfounded statements from the very beginning. Radium has upset no known law, and has not solved the problem of perpetual motion, neither is its energy inexhaustible. At most it has changed our conceptions of what we mean by a chemical element, but here the interference is with a *definition* and not with a *law*. Moreover, the more thoughtful among scientists have usually made verbal and mental reservations in defining an element, thus leaving room for any growth of knowledge or change of conception.

Possibly there are cases in which the motion of electrons in atoms of matter is perpetual within the limitations which are satisfied by the rotating mass isolated in space, but no continuous emission of radiant or other energy would permit perpetuity of action.

The enormous energy stored in a mass of radium is continuously expended in the production of heat, light and ether pulses of the X-ray type; also streams of ionized particles are projected with great violence. These in themselves are further degraded, forming successive emanations of increasingly inert material, each change being accompanied by *loss* of energy. Thus the energetic radium actually changes into inactive matter and *loses weight* in the process.

In some far away period of geological history a certain quantity of matter became possessed of a great and highly concentrated store of energy by virtue of its existence as the highly active and unstable element radium. The ultimate transference of all this energy is as much a matter of time as the stoppage of a

"PERPETUAL MOTION" MACHINES

Inoperative Machines		Operative Machines, but the Motion not Perpetual in the true Sense.
Principle.—Conservation of Energy.	Principle.—Production of Energy.	Principle.—Utilization of Natural Energy.
Initial Supply of Energy to a System Freed from all Retarding Actions (*Retarding Actions cannot be eliminated*).	*All fallacious.*	
Example: Pendulum swinging in a vacuum.	*Examples:* Dynamo and motor coupled mechanically and electrically; arrangements of hinged levers, large cisterns forcing water to a higher level through small pipes, etc.	*Examples:* Tidal, radium and solar motors.

steam engine when all the coal has been consumed.

If an ounce of radium could be made to deliver its 30 h.p. for 2,000 years, it would by that time be correspondingly lighter, and eventually the last trace of it would vanish coincidently with the performance of the last scrap of work done by it.

If we alter our definition to cover machines *which work perpetually so far as man's experience is likely to go*, we include this last class of machines, but where shall the limit be fixed, and is such an expanded definition admissible when man's range of earthly experience in the universe is by comparison less than the beat of a fly's wing in ten thousand years? The comparison is truly inconceivable, yet less unthinkable than the infinite reality.

The three classes of perpetual motion machine may be tabulated as below, and those who are still unconvinced may try to discover a fourth class or to vitiate the arguments used to support either of the three which are given. In any case they are advised to try to fit their pet devices into one or other of the columns. If they *must* demonstrate the wonderful possibilities of mental inertia and perpetual motion along one line of thought leading to infinite and unproductive voids, let them at least attempt to think clearly and scientifically before giving final direction to the energy-impulses of their brains.

How to Make Wood Fire- and Acid-Proof

While the title is something of an exaggeration—for wood cannot wholly be so protected—a treatment that is highly beneficial, especially for table tops in chemical laboratories, is as follows: Prepare a solution by dissolving aniline hydroxide—commonly known as aniline "salts"—in water, to about the appearance of thoroughly black writing ink, also a saturated solution of sulphate of copper (blue vitriol), by dissolving as much of the chemical as possible in water. Give the table top several alternate washings with the two solutions, the aniline first, waiting for each to dry in. It is surprising to what extent the wood will then be immune from action of burning matches, filter paper, heat from gas burners, etc., while liquids can be washed as from tile or marble.

GEAR WHEELS AND GEARING SIMPLY EXPLAINED

ALFRED W. MARSHALL, M.I.MECH.E., A.M.I.E.E.

One of the common methods of transmitting motion is by means of wheels which make contact, or gear, as it is called, with one another. Movement being given to the first wheel, it is communicated by it to the second wheel. Any number of such wheels can be geared together—the movement of the first wheel can be communicated to the second wheel, and by the second to the third, and so on. Two such wheels are called a pair; if there are more than two, the arrangement is called a train of wheels. If the edges or surfaces by which contact is made between one wheel and another are smooth, the power is transmitted by means of the friction existing between the surfaces. The wheel which is transmitting the power is called the driving wheel, and the

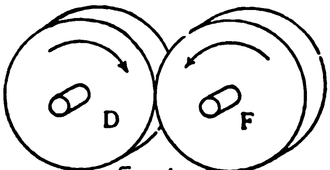


Fig. 1.

one receiving it is called the driven or following wheel. The wheels may be of equal size, or one may be larger than the other. In this latter instance the smaller wheel is called a pinion. Fig. 1 shows a diagram of a pair of wheels in gear. If *D* is the driver, *F* is the driven wheel or follower. Fig. 2 shows a diagram of a train of wheels; if *A* is the driver, its motion will be transmitted by *B* and *C* in turn to *D*. Any one of the wheels can be made the driver; for example, *B*, which will then communicate its movement to *A* and to *D* through *C*. Fig. 3 shows a wheel *W* and pinion *P*. The driven wheel will resist the action of the driving wheel. It will do this because some friction must exist at its bearings even if no other load is placed upon it. The amount of power transmitted by the driver will vary according to the resistance to motion offered by the driven wheel. If this resistance is too great to be overcome by the frictional grip existing between the contact surfaces of the wheels, the driven wheel will lose movement, and there will be slip between

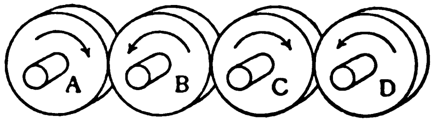


Fig 2

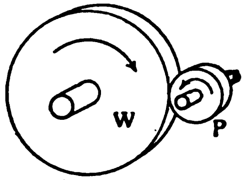


Fig. 3

the contact surfaces. To prevent it the surfaces are cogged or cut into teeth and made to engage positively with each other so that there can be no slip. By this means an accurate transmission of the motion is ensured. Such wheels are called spur or cog wheels.

Imagine a pair of gear wheels, *AB*, Fig. 4; *B* is the driver giving motion to *A*. If we fix a tooth *T* upon *B* to prevent slip, we must cut a groove *G* in *A* for it to engage with or the wheels cannot continue to rotate. A series of such teeth spaced at equal distances may be fixed upon the circumference of *B*, and a series of grooves to receive them cut in the circumference of *A*. Slip cannot then take place. *B* is geared into *A* and drives that wheel positively, or *A* may be the driver and give motion to *B*. This positive engagement between the two wheels is entirely due to the teeth *T* projecting beyond the circumferential surface of *B*. Matters will be equalized, and the time during which any particular tooth of one wheel is engaged with the other wheel will be prolonged, if teeth are placed upon the circumferences of both wheels. In this instance we should place

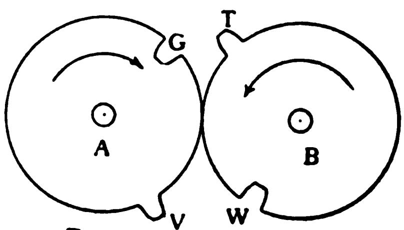


Fig. 4.

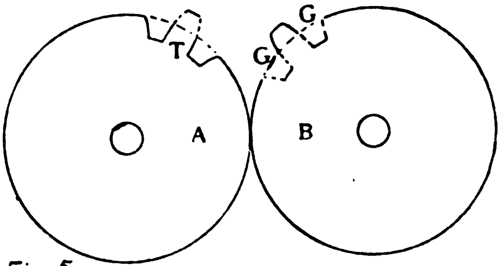


Fig 5.

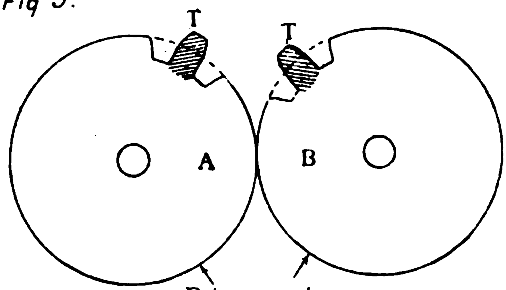


Fig. 6.

teeth V upon wheel A for this purpose. We must then cut grooves W in B to receive these teeth. As A is already cut with a series of grooves, and B is provided with a series of teeth, the new grooves and teeth must be placed at the unoccupied parts of the respective circumferences. The teeth will therefore be placed on the parts T of A, Fig. 5, and the grooves cut in the parts G of B, as indicated by the dotted lines.

This explains that the teeth of a cogged wheel are made up of two parts, one of which is inside and the other outside the true circumference of the wheel, as indicated by the shaded parts T, Fig. 6. When designing a pair or train of toothed wheels we should, therefore, primarily imagine them to be without teeth and merely rolling against one another with frictional contact only. In fact, we should plan them as friction gearing and merely add the teeth to the plain wheels thus designed. The circumference of such a plain wheel is called the pitch surface, usually referred to as the pitch circle, because when setting out the gear upon paper, circles are drawn to represent these pitch surfaces. In Fig. 6, these circles are shown, and represent the imagined pair of plain wheels in contact at their pitch surfaces. The part of the contact surface of the tooth which is outside the pitch circle is called the face, and that part inside the pitch circle is called the flank. The entire portion of a tooth which is outside the pitch circle is called the addendum. When planning a pair or train of wheels, the first consideration is the value or ratio of the gearing. This means the relation between the number of complete revolutions made by the first and last wheels respectively, in any given interval of time; or time can be left out of consideration and the value of the gearing be regarded as the number of complete revolutions which the last wheel will make while the first wheel makes one complete revolution. The first wheel is considered to be the one which sets the whole train in motion. If the last wheel makes one complete revolution while the first wheel also makes one revolution, the train is said to be of equal gear ratio. But if we arrange the sizes of the wheels in suitable proportion, the last wheel can be made to give more or less than one revolution for each revolution of the first wheel.

Fig. 7

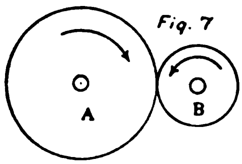
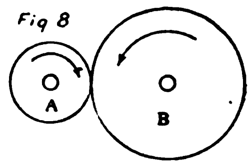


Fig 8



If it has rotated more than once when the first wheel has made one complete revolution, the train is said to be geared up; if less, it is said to be geared down.

The ratio of revolutions is determined by the diameters of the pitch surfaces. Thus, if the wheels A and B, Fig. 6, are to make equal revolutions, B making a complete revolution for each complete revolution of A, the pitch circles must be equal in diameter. If B is to make two revolutions for each one made by A, the pitch circle of B must be exactly one-half the diameter of the pitch circle of A, Fig. 7. Suppose that A is to make one and one-half revolutions for each revolution of B; the pitch circle of B must be one and one-half times as large as that of A, Fig. 8. Thus, the required ratio of revolutions between the driver and driven wheel is determined, not by their diameters as measured over the points of the teeth, but by temporarily leaving the teeth out of consideration and calculating the sizes of the pitch circles as if there were to be no teeth. Having decided the diameters of the pitch circles

the diameters of the wheels measured over the tops of the teeth is determined by adding an allowance sufficient for that part of the teeth which projects beyond the pitch circles. This is shown by Fig. 9, the pitch circles being the dotted lines and the full circles the overall diameters of the wheels. The part of the teeth which projects beyond the pitch circle is shaded. Patterns or blanks from which the wheels will be made would, therefore, be turned to this overall diameter, which thus provides the requisite allowance to complete the teeth. When turning up the wheels in the lathe it is frequently the practice to mark a line representing the pitch circle upon the side of the wheel. This serves as a guide when cutting the teeth and fitting them in their place for working.

The ratio of revolutions between one wheel and the other also depends upon the relative numbers of teeth. If wheel *A* has 20 teeth and wheel *B* 30 teeth, *A* will rotate one and a half turns to one complete revolution of *B*. Therefore, we must not only design the pitch surfaces so that their diameters bear the proper proportion, but we must also make the numbers of the teeth in the same proportion. To some extent this question decides itself, because the teeth upon *A* must be spaced at a distance apart to correspond with the spacing of the teeth which are upon *B*, or the two sets will not fit properly together; the numbers of teeth should, however, always be calculated and made to correspond correctly in proportion to the diameters of the pitch surfaces. Some difficulty may occur in doing this. The distance from the center of one tooth to the center of the next is called the pitch. It is measured along the pitch circle. If the two wheels are to gear properly together, the pitch of the teeth upon *A* must be the same as the pitch of those upon *B*.

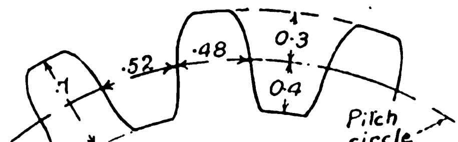


Fig 10

When determining the number of teeth for, say, wheel *B*, you may find that any number which gives a reasonable pitch and is a convenient fraction of an inch, such as 1/8 in. or 1/4 in., will not divide the pitch circle of *A* into the correct number of teeth. You cannot have fractions of teeth. If the wheel centers are not fixed, the matter may perhaps be adjusted by a slight alteration in the sizes of the pitch circles, still keeping them to the desired proportion. If the centers cannot be altered, you must then arrange a pitch which is as near as possible suitable to the available cutters, if the teeth are to be cut, or make a special cutter. There is another method of reckoning the pitch. Instead of measuring it along the circumference, it is measured as so many teeth per inch diameter of the pitch circle. Thus, if a wheel having a pitch circle diameter of 3 in. is to have 24 teeth, they are said to be 8 pitch, because there are 8 teeth in 1 in. of the pitch circle diameter. Awkward fractions of an inch can thus be dealt with in a simple way; No. 8 diametrical pitch would be .393 circumferential pitch. If the circumference of the pitch circle is made of such a size that fractions are avoided, the diameter may be some awkward dimension. By working to diametrical pitch, the pitch circle diameter can be made to a dimension which is convenient to measure. Tool makers use this method to a considerable extent, and supply a variety of cutters made to diametrical pitch. Therefore, as a rule, there is no need

The diameter of the pitch circle multiplied by 3.1416 and divided by the number of teeth will give the circumferential pitch.

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To obtain the diametrical pitch from the circumferential (also called circular) pitch, divide 3.1416 by the circumferential pitch.

To obtain the circumferential pitch from the diametrical pitch, divide 3.1416 by the diametrical pitch.

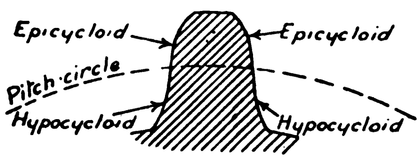


FIG. 11.

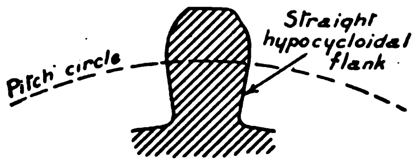


FIG. 12.

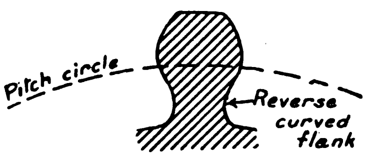


Fig. 13

The size of the teeth is determined according to the power which they have to transmit. They tend to break at the lowest portion—that is, at the root. If the wheels are well fitted, and the teeth make contact throughout the entire width, they will resist the strain much better than if they are inaccurately fitted. In the latter case they may make contact at some place near the edge so that the strain is concentrated mainly upon a small portion of the metal. The power which a gear wheel can transmit increases with the speed of the rotation. If a wheel has a slow speed of rotation, therefore, its teeth must be larger than they need be if the speed is higher to transmit a given amount of power. Generally, there will be two pairs of teeth or more in contact simultaneously, so that you can reckon that the pressure is distributed upon two teeth. All the small classes of gearing likely to be used by amateurs will, in all probability, have sufficient strength when the teeth are made of recognized good proportions so that no calculations need be made for this. If the teeth are to be cut from the solid—and this is the best method for small wheels—the blanks can be sent to a gear-cutter who will select a suitable tool. It will only be necessary to state the sizes of the pitch circles and the number of teeth to be cut in each wheel. When deciding upon the numbers, arrange to have as many teeth as possible consistent with strength and wear. It is not advisable to have less than seven teeth in any wheel.

The teeth are usually proportioned according to the length of the pitch. Different makers vary the dimensions to a small extent. The well-known authority, Professor Unwin, in his "Elements of Machine Design," gives the following (see Fig. 10), the unit being the pitch. These dimensions show that the thickness of a tooth measured on the pitch circle should be slightly less than the width of the interval between the teeth (called the space). Also that there will be a clearance space between the point of the tooth of one wheel and the bottom of the space of the wheel into which it is geared. The width of the wheel is usually about 2 to 2½ times the pitch. When a pair of wheels are in gear, the pitch circles should touch. If such proportions for the teeth and spaces as given in Fig. 10 have been adopted, there will then be a small amount of play between the teeth, as the thickness of the teeth is slightly less than the width of the spaces, and the height above the pitch circle is less than the depth inside it. This clearance allows for very small irregularities, and enables the wheels to run without jamming; it should not be produced by extending the distance between the centers of the wheels.

There is a kind of gearing used in mill work called mortise wheels. In this one wheel of a pair is fitted with wooden teeth dovetailed into slots in the rim. When these are used the proportions of the teeth are altered, the wooden teeth being

made thicker than the metal teeth of the wheel with which it is geared. The object of the gear is to reduce noise. It would scarcely be used for small gearing except as a model of a large gear.

The teeth of cog-wheels require to be made of peculiar shape. It is not sufficient to make teeth of any pattern which will allow them to engage and disengage during rotation without binding. There is a further consideration: they must be of such a shape that the relative velocities of the pitch circles will not be disturbed as they roll one against the other. The pitch circles should continue to roll as if there were no teeth and no slip. Mathematicians have discovered that if the teeth are shaped according to certain well-known geometrical curves, this condition will be practically fulfilled. The three curves which are used in practice are the epicycloid, the hypocycloid and the involute. When made on the cycloidal principle the contact surfaces of each tooth are composed of two curves. That part which is outside the pitch circle is curved to the epicycloid, and that part which is inside the pitch circle is curved to the hypocycloid (see Fig. 11). A cycloid is the curve which is described by a point fixed at the circumference of a circle when that circle is rolled in contact with a straight line. An epicycloid is the curve which would be described by the point if the circle were rolled upon the circumference of another circle. A hypocycloid is the curve which would be described if the circle were rolled in contact with, but inside, the circumference of another circle.

If the curves of the faces of the teeth on one wheel are formed by the same rolling circle which is used to form the flanks of the teeth on the wheel with which it is to gear, the relative velocities of the pitch circles will not be disturbed by the engagement of the respective teeth. This is actually done in practice. The curves are sometimes really produced by rolling a disc representing the curve-generating circle upon another disc or template representing the pitch circle, or are drawn by compasses to some geometrical construction which gives arcs of circles very closely approximating to the real curve. Constructions of this kind are given in text-books on machine construction. The same generating circle can be used to describe the curves for the faces and flanks of the teeth of each wheel; this is convenient and usual in practice, though two generating circles could be used—one for the flanks of the driver teeth and faces of the driven teeth, and the other for the faces of the driver and flanks of the driven teeth. If more than two wheels are in gear together, or if a number of wheels are required to gear indiscriminately with each other—as in the case of a set of change-wheels for a lathe or other machine—it is necessary to use one circle only to generate the curves for the faces and flanks of the teeth of all the wheels.

Many wheels are made with teeth which have straight instead of curved flanks, the lines being radial. This is quite correct, because a hypocycloid generated by a circle whose diameter is equal to the radius of the pitch circle inside which it rolls is a straight line, Fig. 12. The generating circle should not be made larger than this, as the straight line then becomes a reverse curve, producing a weak form of tooth at the root, as indicated by Fig. 13. For this reason the diameter of the generating circle to form the teeth of a set of wheels of different sizes is usually made equal to the radius of the pitch circle of the smallest wheel. The flanks of the teeth of that wheel will then be straight lines, and those of all the others will be curves. But all will be hypocycloids, and the teeth will not be weak at the root. According to Molesworth, the best diameter of the generating circle is given by 2.22 times the pitch, provided the number of teeth in any one of the wheels is not less than fourteen. If the number be less, the diameter of the generating circle should be equal to the number of teeth multiplied by the pitch and divided by 6.3.

Teeth shaped upon the cycloidal principle preserve the relative velocities of the pitch circles only if the wheel centers are at the proper distance apart. If the centers are spread so that the pitch circles do not rotate in contact, the relative velocity is not maintained. If the teeth are shaped upon the involute principle, this condition need not be strictly observed; the relative velocities will not be disturbed if the centers are spread or brought more closely together to a small

extent. Any normal wear of the bearings would thus not interfere with the proper action of the teeth. The involute is a geometrical curve produced by the end of a stretched cord which is being unwound off a cylinder or the circumference of a circle; it would also be produced by the end of a straight line which is being rocked upon the circumference of a circle. In either case the circle is called the base circle, and the curve produced is called the involute of that circle. Teeth shaped upon this principle do not have two curves for their contact surfaces; the face and flank at each side of a tooth is formed by one and the same involute curve (see Fig. 14). The curve is produced by the end of the line *B*, which represents the

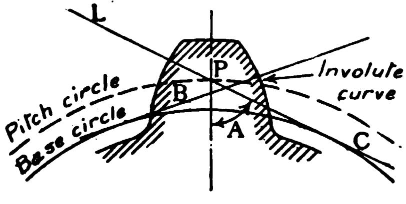


Fig. 14

cord or straight line rocking upon the base circle. Such teeth are of strong shape, and all wheels with involute teeth will work correctly together if the teeth are of the same pitch and obliquity of line of contact. That is, a line *LC*, Fig. 14, making contact with the base circle and passing through the pitch point *P*. For a set of wheels, any pair to work together, the radii of the base circles must bear the same proportion as the radii of the pitch circles. A curve consisting of an arc of a circle can be produced which is very near to the true involute curve; geometrical constructions for this are given in text-books on gearing and machine construction. According to some authorities, teeth shaped to the involute curve exert a thrust along the line joining the centers of the wheels (called the line of centers), thus exerting extra pressure

teeth. The wheels were tried with the teeth engaging at various depths, and did not show any tendency to thrust the centers apart until they were placed with the teeth engaged only to a depth of ¼ in. out of a total depth of 1½ in.; even then the tendency to separate the centers was very slight. Involute cutters are stocked by tool dealers, and the curve is favored in American practice. If the angle *A*, Fig. 14, be made as large as practicable, involute teeth appear to give good results in working. The effect of increasing the angle *A* is to bring the circumference of the base circle close to that of the pitch circle, the result being short teeth.

(To be continued)

Wireless Telegraphy without Sparks

According to the *Matin*, a young French engineer has made a discovery which is likely to revolutionize wireless telegraphy. The article in the *Matin* says: "The author of this wonderful discovery is M. Julien Béthenod, a favorite pupil of Henri Poincaré and a personal friend of M. Branly. This young scientist is already known as the inventor of an alternator, by means of which messages are sent out by wireless sound sparks. This alternator is in use at the Eiffel Tower, and is employed for military and naval purposes in several places in the Colonies. The invention of M. Julien Béthenod consists in the main in this, that it substitutes for wireless telegraphy with sparks wireless telegraphy without sparks. In the case of wireless telegraphy with sparks, the materials required are: (1) an alternator; (2) a transformer; (3) a self-induction coil; (4) a condenser; (5) an oscillator; (6) an antenna. With wireless telegraphy without sparks, on the other hand, all that is necessary is an alternator and an antenna. Of course, it is a special antenna that is required, as well as a machine that is capable of sending out waves on the antenna that

INFLUENCE OF ANTIQUE MODELS ON PRESENT-DAY FURNITURE

Various Forms of Tables Described—The Tray Table—The Telephone Table

PAUL D. OTTER

It will be found that the influence of "periods" actively determines our form of furniture as does the period style of the building determine the nature and decoration of the room within, and so it is with the intention of dividing the furniture family under headings that the subject of tables is now considered. It is not so much what we make for ourselves in unrestrained enthusiasm, urged on by watching the clean shavings curl from our plane, but it is what others might think of our product when we get through with it that impels us to consider with some deference, what is in the market?—what kind of furniture is the home furnisher seeking?

In this inspection of present furniture it will inspire the practical tool user with increased confidence to know that many of the furniture forms bought by discriminating purchasers he can make for his own home and use also as models for private orders.

With this idea in mind the present subject has been prepared, presenting types of simple construction and of a character which will harmonize well in the furnishing of the modest home; particularly will others fit in well with the bungalow and concrete order of home, the character of which originally springs from the same source as shown in many under consideration.

Having a two-fold use, Fig. 1 is very desirable in the small cottage or bungalow home where the dining-room is frequently the living-room. It is well adapted for beginners in the home life, and when not in use looks well against the wall as a settle, particularly when the room has a timbered or paneled treatment.

It might be well to note here in passing that all such pieces of furniture never look well in natural or light finish, even golden oak finish, for much of the square furniture is too light. The main purpose and most satisfactory color finish is to get age brown tones immediately, as they blend well with draperies, rugs and all other furnishings. Such a tone, you will notice, accords well with standard tones adopted by the architect and decorator. This age tone is commonly known under

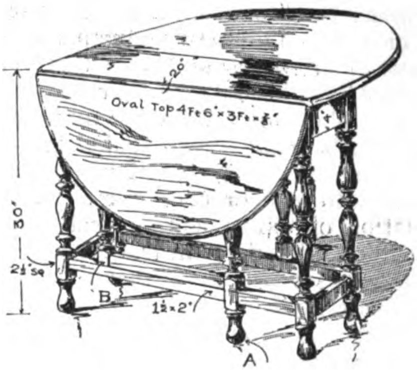
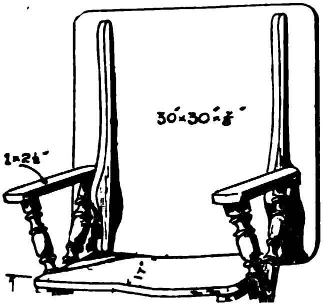
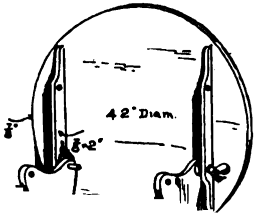
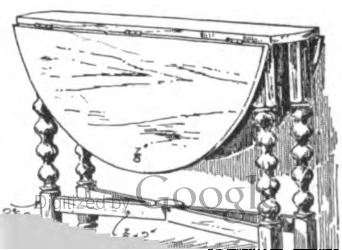


Fig. 4—A Gate Leg Table







the name of "fumed oak." "Cathedral oak" is another pleasing shade of brown. Oak is also a safe wood to use for furniture of a medieval type, or that which partakes of a sturdy character and possesses a combination of square and round-turned parts.

It is assumed a sufficient working drawing be made showing the end view of the subject and also one-half of the front view. With the skill of a workman and the experience in getting out and handling stock much of unnecessary and familiar detail need not be placed on the drawing if time does not permit. The use of the drawing will be to pencil in between determined measurements unknown detail of form and outline. Other simple parts may with judgment be arranged for and fitted as the work proceeds.

These remarks do not, of course, minimize the value of a clearly defined working drawing, should there be any need of referring to it at some later time or of making a modified interpretation of the same class of subject.

Well-seasoned wood should at all times be made use of and generous well-fitting tenons be given to the cross stretchers, which should go clear through the thickness of cross legs and be further secured either by a headless brad or a hardwood peg. The top of the table may operate on a bolt or lag screw secured through a hole in the enlarged part of batten and pass into arm or back post. This is a matter of experimenting and also the location of top in central position over the base when down in place.

Little need be said of the settle table in Fig. 2, except to call attention to another use of the compartment under the lift-up seat. This is entirely of 7/8 in. boards. The drawing here shown represents a familiar type of early English or early colony utility table. It admits, however, of varied outline and more elaborate treatment. Sometimes the seat is padded and upholstered with a padded and upholstered panel treatment, covering much of the space within the battens of the underside of the top. This, then, to use an expression, "puts it in another class" and identifies it more with the furnishings of a craftsman's living room.

It is desired by the aid of the cuts shown to excite individual expression as much as possible. Much of the old furniture is interesting from the ingenious devices or construction, designed just as much then as today to serve a double purpose, and it is hoped that the spark of inventive genius may be fanned into a flame of enthusiasm for other simplifying means or comfort-giving features. Meanwhile curb any desire to change good form for some untrained outline or erratic profile to your turnings; rather seek out and make a rough pencil sketch of a bit of turning or an approved outline which you think would apply to a particular form of furniture needing a little more grace or livelier expression to it by a change of outline, or an added bit of modest carving or molding.

Fig. 3 presents an English breakfast table which is coming again into renewed favor. It has its advantages of looking well when not used as a meal table and of being useful for other purposes.

The marked revival of needlework among ladies demands attractiveness in table designs, and for this reason the antique models are more than ever being reproduced, fashion dictating that luncheons be served on bare table tops over open lace-work doilies and scarfs. A becoming design of table is therefore much in demand. A simple turned shape to the posts of the Jacobean period is shown, although other profiles may be used. Two specially fitted hinges screwed firmly in the usual way to ends of leg strainers and brought together by a central pin covered by finishing cap will provide one of the many ways of throwing open the legs to a square position under the table top.

Certain unobtrusive stops and a locking device are to be provided to check the posts at a determined position. Whatever may be the diameter of the table, make the center of the table about 3 in. less than a third of the diameter.

The size of leg stock shown on cut is for the larger size of table, 48 x 48 in.

Fig. 4 is now one of the very popular forms of gate leg tables—most frequently made in mahogany. This fits in well with furniture of a mahogany order, as does most of the William and Mary style, of which this is a suggestion.

The gate with the halved out post *A* fitting into cross rail correspondingly halved in a loose fitting manner, pivots or

swings out from post, loosely pivoting on top of rail. The corresponding gate on other side of table swings out in a similar but alternating direction, stopping at a check at right angles with the table frame. All dropleaf tables should be treated with a rule joint contact with leaf and top of table.

Fig. 5 meets with favor now even though its class was replaced by the pedestal table; yet it, too, has the merit of side-wall attractiveness which the modern table cannot have. The leaves are usually supported by a stiff swinging cross bar set into top of apron rail. Care should be used in the selection of dry

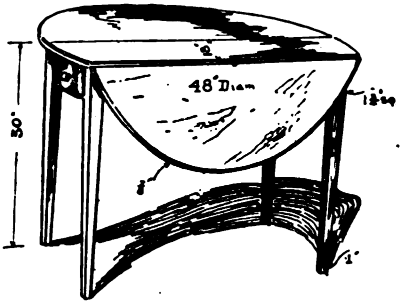


Fig. 5—A "Sheraton" Dining Table, 42 or 48 In. in Diameter

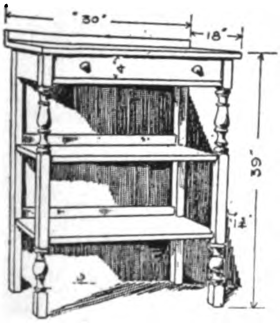


Fig. 6—A Serving Table

lumber for the tops and also to screw on a batten, using *no glue*, but setting each screw in a small slot so that the top may shrink and expand unretarded.

Mahogany, or mahogany-finished birch is properly the wood for this table, and more particularly if it is made in a smaller size than a 42-in. top.

We used to feel very well satisfied with the ordinary dining-table and a direct communication to the kitchen and the pantry, but now our needs, through a process of refinement, must take on considerable complexity, all of which adds to home charms and the wife's pleasure in displaying in an attractive way and on suitable furniture her growing collection of silver, cut glass, decorated ware, and last but not least, her linen, for every day or on festal occasions. This requires us to show Fig. 6, a serving table, which is very simple and plain, being a sort of second cousin of the more aristocratic sideboard. It is one remove from the buffet, and consequently, about fits in with our modest ideas of living, and the useful furniture we need about a bungalow or that class of home.

Little need be said about this, except that a form of frame made similar to one suggested in Fig. 13, is to be used as a base of construction, and the two lower shelves are to be cut out and fitted in a similar manner. The shelves may be secured to posts from the underside by means of

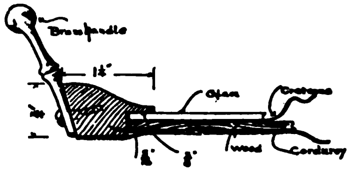


Fig. 8—Section of Serving Tray for the Tray Table Shown in Fig. 7

Fig. 7—A Tray Table to Fit Glass Tray 10 x 25 In.

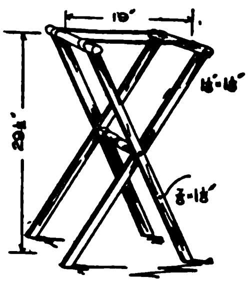


Fig. 9—Tray Stand to Be Used in Connection with Glass Tray, Fig. 8

a counterbored screw hole bored on a long slant. This simple sideboard is becoming a necessity, as in a home without servants it permits of extra table furnishings and the desserts to be placed in readiness before the meal is begun, thus creating greater repose for the housewife.

Fig. 7 offers a good substitute or even an adjunct to Fig. 6, being a tray table which provides a proper resting-place for the glass-filled tray when not in use.

We do not pass the social hour or two without on many occasions being served

with refreshments, and the tray has truly become a necessary article, and like everything else an object of attractiveness and friendly rivalry as to who will own the prettiest tray.

Fig. 7 may properly have a second drawer, although where the lower shelf might be used for a fruit bowl such an addition may destroy the decorative effect.

The glass tray, Fig. 8, which in this instance determines the size of table top for Fig. 7, consists of a molding of oak or mahogany cut from a stick $\frac{3}{4} \times 1\frac{1}{4}$ in. of a section, preferably the one shown. These pieces are cut to a mitered frame measuring over all 16 x 25 in. Long brads properly set in and concealed, or a $\frac{1}{8}$-in. saw kerf run across the glued up frame at an angle of 45 degrees with a slip of wood set in glue and trimmed off, will probably produce a more dependable joint. A piece of good, clear, clean single thick glass, a piece of attractive figured cretonne with birds, foliage or flowers, a piece of dry thin board or flat stiff straw board, are to be cut to fit not too tightly within the rabbet size of the frame, then with a number of stiff, thin brads securely nail in position; a small, round reed or stick is sometimes used to brad in over the backing. As a final covering of this surface and also to extend over the bottom face of frame, glue on an extra large piece of corduroy, preferably brown, green or gray, starting from one end, and using some stiff paste, or rather thick prepared glue, which has little moisture. After this covering is set and dry, use a sharp knife in trimming off the material overhanging outer edges. Brass handles are now to be had for such trays, and care should be taken to set the screws into the light frame in a prepared hole small enough to make the screw draw up firmly.

Fig. 9 is a collapsible table or stand to support tray in kitchen or pantry when receiving contents previous to carrying to dining-room tray table, Fig. 7, or in to guests during some social gathering. It is quite a useful article for large gatherings where other table space is being used, and is also necessary for the welfare of a handsome tray when away from its proper place.

THE SEWING TABLE

Among the many kinds of tables the sewing table provides an orderly place for materials and ample space to lay out work on the top and extending leaves. The plain and less expensive type shown in Fig. 10 in mission style is here used as a basis for any different treatment the reader may wish to give it and not depart from form or size of parts. The legs may be treated with a squared neck or lessening of stock under the lower drawer frame and the major part of post reduced to a taper and expanded again before it reaches the floor into a square ball effect; or this full length may be turned by using some well selected taper form. The shelf and top may then be treated with a molded edge and slightly rounded corners and the rule joint be used instead of plain square.

Fig. 11 is a more pretentious table properly made in mahogany. This is the type the interested worker will find gives him the opportunity for skilled workmanship, and in the drawers he may insert various small compartments and specified divisions which would delight the future possessor of such an article.

By the use of Fig. 12 the manner of gluing up stock is shown, and may be resorted to for producing a flowing shape or outline, which is frequently wider than stock obtainable. The heavy line shows the proposed shape of one-half of lyre pedestal to work table, Fig. 11, allowing length for large tenons, top and bottom *A* to fit in mortise in frame, Fig. 13, and the lower tenon to fit in molded base above scroll feet in Fig. 11. Before the outline indicated in heavy line is sawed out, unite the two halves by gluing. This will enable you to use long clamps on flat surfaces. When dry, saw out on band saw and cut tenons.

The frame, Fig. 13, here shown is a base in most all forms of modern construction of carcass work. If the reader will inspect any available piece of furniture of a case of like nature, he will find this frame to be a convenient one upon which to secure other constructional parts. In many instances it is not in outward evidence, while in the case of the sewing table, Fig. 11, it appears between the two drawers and above and below. Where thus exposed to view the stile should either be faced with veneer or be of the same kind of wood as the entire construction; these frames otherwise may be made of inferior wood, gen-

erally of ¾ or ⅞ in. thickness, and 2 or more inches wide, judgment showing whether one or more crossbars will be needed for extra stiffness.

A preparatory working drawing which you should make will indicate where you are to relish out the corners, as instanced in Fig. 13, to provide a place for the jamb blocks on each side of drawer. The ends of the carcass hidden by the drop leaves in the cut are glued and secured by screws to these frames by screws countersunk or set in, as shown at *B*.

USE OF CORNER BLOCKS

A double insurance of strength and stiffness is always secured in cabinet work by setting in frequent corner blocks;

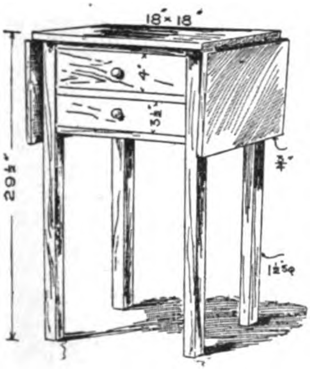


Fig. 10—Serving Table Having Top Area When the Leaves are up, 18 x 33 In.

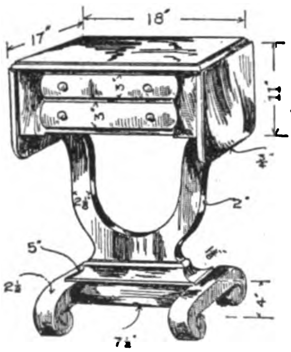


Fig. 11—Colonial Sewing Table 30 In. High and Top When Both Leaves Are Up, 18 x 40 in.

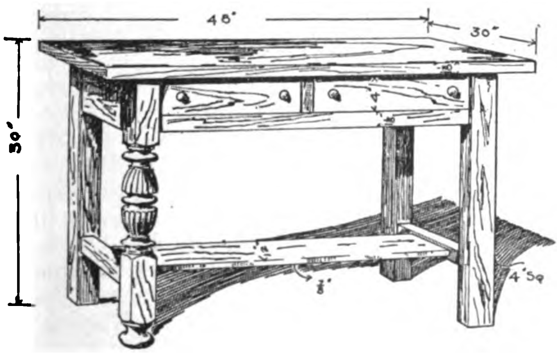


Fig. 14—Mission Table Showing "Elizabethan" Treatment on Left Leg

these may be made of neatly cut triangular blocks or strips two or more inches in length.

The upholding of the drop leaves may be secured by various means, and I take it that if it is a pleasure to construct an article it is equally interesting to study out and provide certain ingenious devices which further embody personality in one's productions. Various holding-up methods are used on such tables, the

Fig. 12—Half Shape of Lyre Pedestal Showing Manner of Gluing Up Irregular Shape

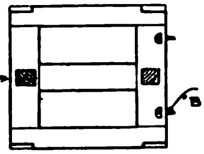


Fig. 13—Frame for Sewing Table

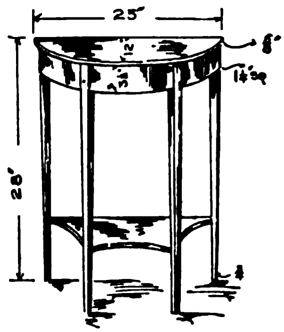


Fig. 15—A "Sheraton" Side Table

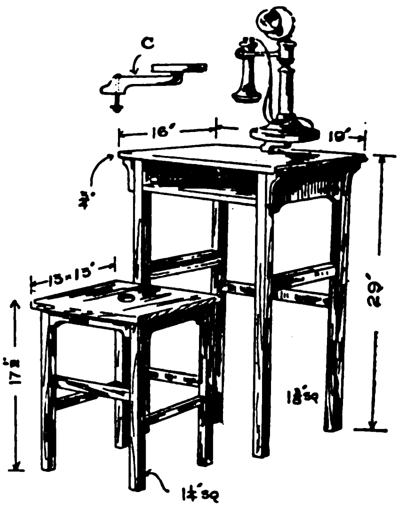


Fig. 16—A Telephone Table and Stool

simplest possibly being a swing bar, space for which must be provided for its action under the middle part of the table top, or sufficient space may be provided on your drawing so that the middle top shall hang over sufficiently to hinge to each side of the case a ¾-in. swing bracket long

enough properly to support the drop leaf when drawn up.

Our broad-handed way of living makes the subject of tables very varied, as each room appears to demand a special form of table, but I am going to give the parlor cant attention at present, for that room s falling much into disfavor. Fig. 14 shows a very popular and approved form of convenience table for the living-room. It is of the mission order, yet for those who wish a less heavy effect, the left leg is shown turned in the Elizabethan style, which will be found to modify the overweighty appearance, and permit of its use in greater harmony with a mixed assortment of furniture patterns, which are generally to be found in a living-room. Such tables are generally made in three sizes, 40 x 30 in., 42 x 28 in. and 36 x 26 in.

Fig. 15 is a graceful form of table adapted to a ladies' room, parlor or reception hall, and should be made in mahogany or other rare wood.

The top is semi-circular and the apron is sawed in conformity and set under very slightly, about ⅜ in.; the legs are 1¼ in. square and mortised between the aprons and reduced by a taper to ¾ in. at floor. By making a small grooving tool or plane, a groove of 3-32 in. square may be plowed in ¼ in. away from edges of legs on front and also on apron front and one groove in edge of table top, into which may be set in glue a strip of wood or veneer of a lighter color. Let dry and then scrape flush with cabinet scraper and sand smooth with No. 00 sandpaper.

THE TELEPHONE TABLE

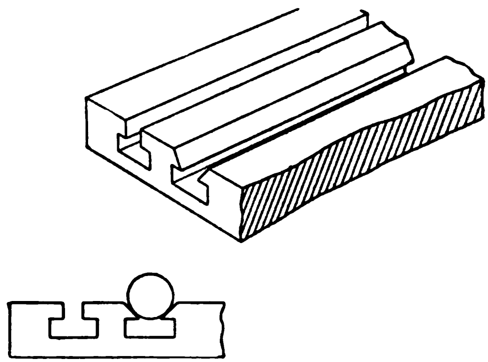
The telephone table, Fig. 16, I am sure will be highly valued in the home, particularly by the feminine members of the family. The style is a modified type fitting in well with the "Mission," "Quaint" or "Arts and Crafts" style so prevalent. The simple general form is one permitting various changes in leg treatment and shape of outline to apron. An undershelf in table provides for the telephone book. The top, shelves and side rails are of ¾-in. material. The table stand is so made with the side strainers or stretchers provided with a

of stool top to facilitate withdrawing it. A wooden arm represented in *C* and a turned disc to hold telephone stand is secured by a bolt with nut and washers to table top at back so that instrument may be swung back or forward for convenience.—*Building Age.*

A Hint for Cutting Keyways

AN APPRENTICE

The accompanying sketches show an easy and practical way of ensuring a keyway to run parallel with the shaft. Most planing and shaping machines have one or more slots running longitudinally with the table. If one of these slots be planed



A Method of Cutting Keyways Parallel

the whole length of the table to an angle of 90 degrees so that a shaft may rest in it as in a V-block, it will amply repay one for the trouble expended on it. It will also stop the shaft from buckling under the pressure of the cutting tool.

Reporting Obstructions by Radio Telegraphy

Shipmasters in the North Atlantic are invited to communicate reports of dangerous obstructions to navigation to the Hydrographic Office, Washington, D.C., or to the nearest Branch Hydrographic Office, by radio telegraphy at or near the time of seeing the obstruction. Such messages should be brief and in English. They should be addressed *via* any naval or commercial radio telegraph station along the coast of the United States. The cost of their overland transmission will be borne by the Hydrographic Office. Particular attention is invited to the

INDUCTION MOTORS AND HOW THEY WORK

NORMAN E. NOBLE

In this article it is intended to deal with the description of induction motors and principle upon which they work. This is a subject that most amateurs (whose study of alternating current motors has not progressed very far) consider somewhat of a mystery, and it is for their benefit that this article is written. I have endeavored, as far as possible, to keep the description and drawings as clear as I can, considering the nature of the subject; also the mathematics of induction motors have been left out entirely, as they are rather complex and might have induced the amateur to slip over some of the most important points. It has been assumed that those who wish to study the principle of induction motors have a good all-round knowledge of the properties of direct-current motors and apparatus, and have also a slight knowledge of the fundamental principles of alternating currents and one or two of its peculiarities, as induction motors depend upon alternating current for their power. However, for those whose knowledge is slightly rusty, I will commence with a brief description of their derivation.

An alternating current is one that is neither constant in direction or pressure, but varies—first flowing in one direction round the circuit, commencing from a zero value and rising to maximum, and then back to zero; it then changes its direction and flows round the circuit in the opposite direction: from zero to a maximum, and back to zero. This cycle of operations is repeated at regular intervals of time.

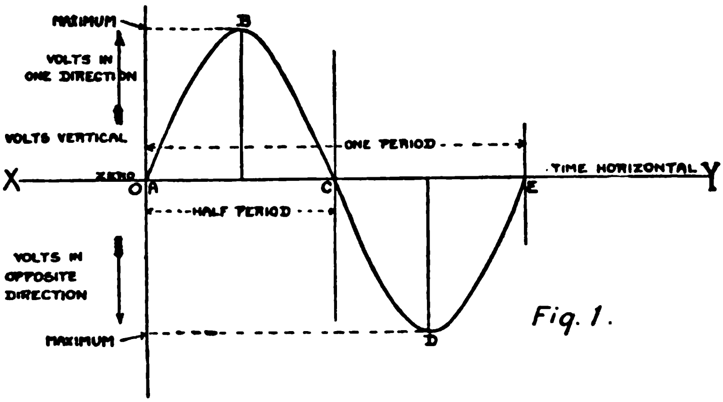
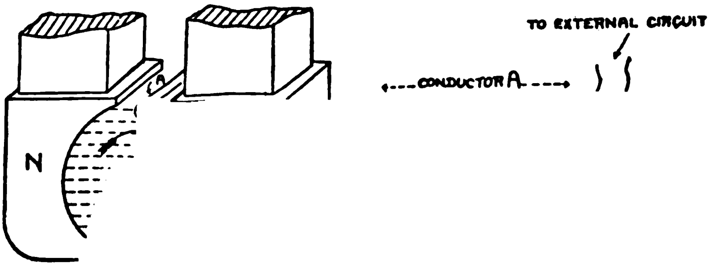


Fig. 1.

Let us now consider Fig. 1, in which the curved line represents an alternating current, and shows the variation in direction and pressure. The line $X\ Y$ represents the zero line—volts in one direction being marked above the line, and volts in the opposite direction below the line, time being marked horizontally. The current starts at a zero value at A, and increases, at a varying rate (as shown by



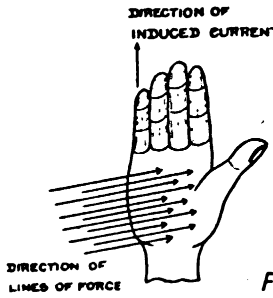


Fig. 3.

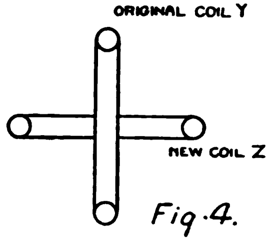


Fig. 4.

the curve), to a maximum value at B; then it decreases from a maximum to a zero value marked C, all in one distance round the circuit. The direction is now changed, and the current increases from a zero value at C to a maximum value at D, and then down to a zero value at E—all in the opposite direction round the circuit. This complete cycle of variations—that is, from A to E—is called one period; this period or cycle of variations is repeated at regular intervals of time, each period occupying 1-50 or 1-25 second, according to the design of the alternator supplying the current. Thus, we get a current having 50 or 25 complete periods of variation per second; of course, we can get currents having 100 or 60, or any other number of complete periods of variation, but 25 and 50 periods per second are the most common; the periodicity or frequency of the current being a fixed quantity for any particular alternator at its proper speed.

We will now consider how these alternating currents can be produced. For our illustration let us consider a single coil of wire revolving in a direct-current magnetic field, and each end of the coil being connected to a separate slip-ring. (See Fig. 2.) The coil E is assumed to be rotating in a clockwise direction, as indicated. As the coil revolves, the conductor A cuts the lines of force in one direction; this induces an e.m.f. in the conductor, which causes a current to flow, the direction of which can be easily determined by remembering the following simple rule: "Hold the palm of the right hand so as to meet the lines of force (coming from the N. pole to the S. pole), and place the hand so that the thumb indicates the direction of motion of the conductor, and the fingers will point out the direction of the induced current." (See Fig. 3).

If this rule be applied to Fig. 2, the induced currents will be found to flow in the direction shown by the arrows. We will now deal with the currents generated during the first quarter of a revolution (that is, 90 degrees). Considering the conductor A, this will start cutting the lines of force gradually, and as it rotates will cut an increasing number of lines, until, when it has moved 90 degrees, it is cutting a maximum number of lines. Now the e.m.f. induced in any conductor is directly proportional to the rate of cutting; therefore, it will be seen that the e.m.f. generated during the first 90 degrees of a revolution corresponds to that portion of the curve, Fig. 1, from A to B. Of course, at the same time there is an e.m.f. generated in the conductor B, Fig. 2, which assists that generated in the conductor A. During the second quarter of the revolution (that is, from 90 degrees to 180 degrees), the number of lines cut is a maximum at the commencement, and gradually decreases to zero; thus, the e.m.f. generated in this portion of the revolution will vary from a maximum to a zero

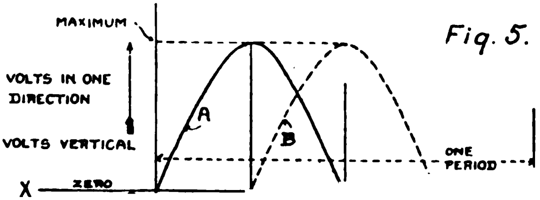


Fig. 5.

conductors cut the lines of force in the reverse direction; the e.m.f. generated will vary in pressure from zero to a maximum, as in the first quarter of a revolution, and will correspond to that part of the curve C to D, and, finally, in the last quarter (that is, from 270 degrees to 360 degrees), the e.m.f. generated will vary from a maximum to a zero value (as in the second quarter), and corresponds to that portion of the curve D to E, Fig. 1.

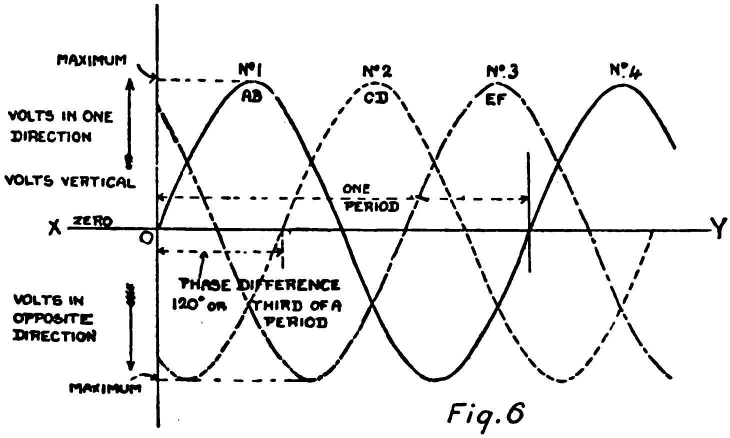


Fig. 6

The current produced by this single coil revolving in a two-pole field, as in Fig. 2, is a single-phase alternating current, and we get one complete period produced during one revolution of the coil; therefore, to get 50 periods per second, we must rotate the coil at 50 revolutions per second. If we had a four-pole field, we should get *two* complete periods during one revolution of the coil; so, under these conditions, we need only revolve the coil at 1,500 revolutions per minute to produce 50 periods per second. Hence, as we increase the number of poles of the field, we increase the periodicity of the current (that is, of course, for a given speed). Therefore, to find the periodicity of an alternator, we have: Periodicity per second equals revolutions per second times number of pairs of poles.

Referring back to Fig. 2, we had one coil only. Now, suppose we wind another similar coil at right angles to the original coil, and connect it to two more slip-rings (that is, four altogether), Fig. 4. The coil Z would be generating a maximum e.m.f. when the coil Y was generating no e.m.f., and *vice versa*; so, if we revolve these two coils in a two-pole magnetic field, as before, we shall get two alternating currents, one having its maximum value when the other has its zero value, the difference between the two being 90 degrees, Fig. 5. This is called a two-phase current, the phase difference being 90 degrees. Curve A represents one phase, and the curve B represents the other phase. As regards the periodicity of the currents, it is exactly the same as previously pointed out—that is, it depends on the speed and the number of pairs of poles. If we had to wind three coils having 120 degrees between each of them, we should get three currents having a phase difference of 120 degrees, Fig. 6. This is all that will be said on the derivation of alternating currents.

Induction motors can be made to run on either single-, two- or three-phase current circuits. We will consider two-phase motors first. Let us take a soft iron ring-shaped core, as shown in Fig. 7—(it must, of course, be laminated to prevent eddy currents)—and wind a coil of wire in two halves, A and B, on opposite sides of the ring. If we now pass a direct current through the coils in the direction shown, we shall get a magnetic field produced inside the ring, as indicated

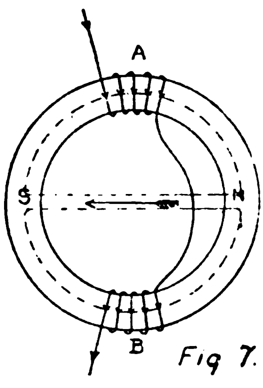


Fig 7.

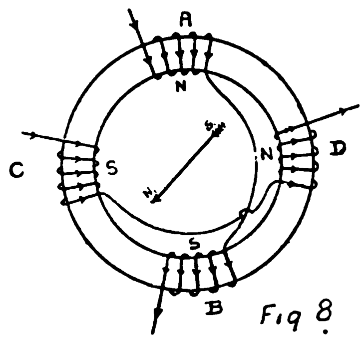


Fig 8

by the dotted lines, the N. and S. poles being as shown; if we put a small compass needle in the center of the ring, it will, of course, take up a horizontal position. Let us now wind another similar coil of wire in two halves *C* and *D*, and at right angles to the coils *A* and *B*, Fig. 8. If we pass a direct current through the coils *C* and *D* in the direction indicated, we get a vertical magnetic field, having its N. pole at the top and its S. pole at the bottom. If we now pass the same current through both coils in the directions shown, simultaneously, we get two magnetic fields at right angles to one another, and a compass needle placed inside the ring will take up a position midway between the two fields, as shown in Fig. 8. Turning back to Fig. 7, let us supply the coils *A* and *B* with an alternating current (single-phase); therefore, we shall get a current flowing first in one direction, and then in the other. At one particular instant the current would be flowing as indicated by the arrows, and consequently would produce a magnetic field having its N. and S. poles in the ring, as shown. The strength of the field would gradually increase from zero to a maximum, and then decrease to zero. Then, with the current changing its direction, the poles of the magnetic field would be reversed—that is, the N. pole would become S., and *vice versa*, during the period that the current was flowing in the opposite direction to that shown. The result is—we get what is called a pulsating field, and a compass needle placed inside the ring under these conditions would first be pulled in one direction and then the other; and if we looked closely at the needle we should be able to see a visible vibration, but no rotation, unless we first gave the needle a twist; the reason being that the needle has not time enough to turn partly round in one direction before it is

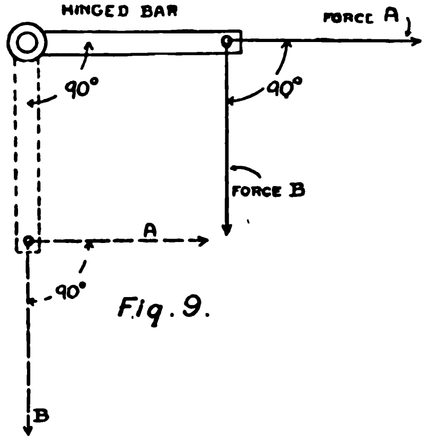


Fig. 9.

the two methods is suitable for producing rotation. To produce rotation we require a rotating field, and not a pulsating field.

The production of a rotating field can be accomplished by supplying two or more suitably placed coils with alternating currents differing in phase; by that is meant—one current attains its maximum value a certain fixed time after or before the other. Let us take a two-phase current (that is, one quarter of a period phase difference, Fig. 5), and supply the coils *A* and *B* with one phase of the current, say, the lagging current, and the coils *C* and *D* with the other phase (that is, the leading current), Fig. 8. Under these conditions we shall get a rotating magnetic field revolving at a uniform rate in a clockwise direction in this case, and if the following explanation be carefully studied, the reader will have got over the most difficult part, and one which causes trouble to many amateurs. At that instant when the current in the coils *A* and *B* is at zero, the current in the coils *C* and *D* is at a maximum, and is assumed to be flowing in the direction ... the magnetic field

poles as per Fig. 8. This would be the case if we consider the coils separately; but as the magnetic field due to the coils *C* and *D* is weakening, owing to the current's decreasing in value, the magnetic field due to the coils *A* and *B* is increasing in strength, hence the two fields act upon one another at right angles and produce a rotating field having its position at any instant in between the two fields, and its relative position between the two being directly in proportion to the strengths of the two fields. Thus, at the beginning the field produced by the coils *C* and *D* is vertical, and the field due to the two coils *A* and *B* is at zero value; now, when the currents have passed through a quarter of a period, the field due to the coils *C* and *D* is at zero, and that produced by the coils *A* and *B* is at a maximum and is horizontal; therefore, it will be seen that the magnetic field has moved a quarter of a revolution in a clockwise direction in the same amount of time that the currents have passed through a quarter of a period variation. Now, the movement of the magnetic field from one position to another is not instantaneous but is uniform, because when one set of coils is producing its maximum magnetic field (which gradually decreases to zero), the other set of coils is producing a zero field (which gradually increases to a maximum value), and both are varying at the same rate of change. This can perhaps be made a little clearer by comparison with an everyday fact: Suppose we have two ropes attached to a hinged bar, Fig. 9, at right angles to each other, a force *A* pulling at one rope, and a force *B* pulling at the other. Assume that the force *A* starts at 10 lbs. and gradually decreases at a certain rate to nothing; and the force *B* starts at nothing and gradually increases (at the same rate that *A* decreases) to 10 lbs. It is quite evident that at the commencement, the hinged bar will be in a position as shown by the full lines, and that at the completion of the experiment the hinged bar will be in a position as shown by the dotted lines; also, at any intermediate point between the initial and final positions, the bar will be in that position the resultant of the two forces occupies, seeing that the two forces are varying continually and at the same rate of change; therefore, the resultant must be constantly changing its position. These two varying pulls *A* and *B* are comparable with the two varying field-strengths produced by the coils in the previous case, and the hinged bar is comparable with the revolving field. This analogy, no doubt, will help the reader to understand how a rotating force can be produced with alternating currents.

Returning back to our consideration of Fig. 8, we had arrived at the point when the field due to the coil *A* and *B* was at a maximum and horizontal. The current in these coils now begins to diminish to zero, but at the same time the current in the coils *C* and *D* begins to increase from zero to a maximum value, but the direction of the field is reversed, owing to the current's having changed its direction.

The resultant field, or revolving field, will now move away from the weakening field and towards the strengthening field—that is, it will move another quarter of a revolution in a clockwise direction during a quarter of a period in variation of the currents. If the remaining operations be gone through in a similar manner to the above, we shall get one complete revolution of the magnetic field for one complete period of variation of the currents, Fig. 5.

We shall now have to consider how we can utilize the rotating magnetic field so as to produce a rotary movement of a body in it. It is quite true that if we placed a compass needle inside the ring supplied with two-phase currents, that we should get a constant rotation of the needle, this being so because the needle is bound to lie in the magnetic field, and compelled to revolve because the field does.

Now let us consider a well-known fact, and see how it will help us. It is known by most amateur electricians that if we rapidly rotate an iron ring or a solid piece of iron in a strong magnetic field, the iron will eventually become warm, and perhaps very hot, if the speed be high enough; the explanation of this being that the rotating ring cuts the lines of force, and an e.m.f. is induced which produces currents which circulate in the iron and cause heating effects. These induced currents oppose the motion which causes them (by Lenz's law). The

same effect would be produced if we rotated a magnetic field round a stationary iron ring. Thus, if we place an iron ring in the rotating field—as produced by the two-phase currents in Fig. 8—before we pass current through the coils, the iron ring will be stationary. Now, when we switch the current on, a rotating field is produced, which, as it revolves, cuts the ring, and obviously, from the above example, induces currents in the ring. These currents produce a magnetic field which opposes the rotating field; but the iron ring, being free to revolve, is carried round with the rotating field, because it cannot stop it.

Let us now consider a simple form of induction motor, as in Fig. 10. The motor consists essentially of an external ring-shaped iron core, which is called the stator, because it comprises the stationary part; on the inside of same are cut slots into which the field coils can be wound. The rotating part, named the rotor, consists of an iron core with slots in the periphery, in which the rotor conductors are placed. The conductors can be connected in many ways; the method we will deal with first is shown in Fig. 11, and is known as a squirrel-cage rotor. In this type of rotor both ends of the conductors are short-circuited by means of copper rings, Fig. 11. In both the case of the stator and rotor cores, they are composed of thin sheets of iron insulated from one another; this is done to prevent eddy or induced currents flowing in them.

In the stator there are four slots, *A* and *B* being for one winding of the two-phase current, and *C* and *D* for the other phase winding. When the slots are wound and each coil supplied with one

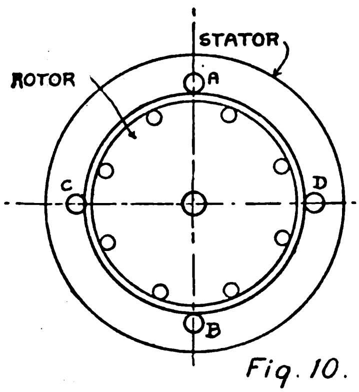


Fig. 10.

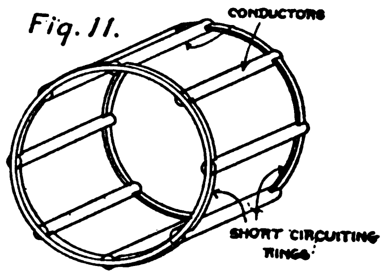


Fig. 11.

phase of a two-phase supply, we get a rotating field. As the field rotates it cuts the rotor conductors and induces an e.m.f.; and because the rotor conductors form a circuit, a current flows in them which produces a magnetic field opposing the rotation of the stator field. The rotor, however, is free to rotate and is carried round with stator field, and we can derive mechanical energy from the rotor shaft. The speed of the revolving field depends on the periodicity of the supply, and also on the number of pairs of poles of the revolving field. For example, in the above case the revolving field has one pair of poles; assume the periodicity of the supply to be 50 cycles per second. Now speed of field in revolution per second is equal to

$$\frac{\text{periodicity of supply}}{\text{number of pairs of poles}};$$

therefore, in the previous example we shall get a field speed of 50 revolutions per second, or 3,000 revolutions per minute, which is the same as we got from Fig. 8—that is, one revolution of the field for one period in variation of the currents. The induced e.m.f. in any conductor depends on the rate the lines of force cut it and the strength of the magnetic field; hence, when we switch the stator windings onto the supply, the field immediately revolves at full speed and the rotor is at rest, consequently, the lines of force of the revolving field cut the rotor conductors at a maximum rate, and an induced current flows in them, producing a magnetic field which opposes the rotation of the stator field and tries to stop it; but as long as we pass current through the stator windings, the field will revolve at a constant rate, hence the rotor is carried round with it in the same direction as the stator field revolves in.

Now, with a supply having a periodicity of 50 cycles per minute, we get with a

motor, as shown in Fig. 10 (that is, a two-pole motor), a field revolving at 3,000 revolutions per minute, and just as the rotor is starting from rest, we get the lines of force of the stator field cutting the rotor conductors at a maximum rate, hence inducing a maximum current, which, in turn, gives a maximum turning effort. Assuming the motor is running light, the rotor will quickly increase in speed, and will reach almost the same speed as the revolving field, which is rotating at 3,000 revolutions per minute. It cannot, of course, reach exactly the same speed, because if it did the stator field would not cut the rotor conductors, hence no currents would be induced and, consequently, no turning effort available. But a motor running on light load only requires a sufficient torque to overcome the frictional and air-resistances of the moving parts, and it would be found very difficult to determine by means of a tachometer any appreciable difference between the theoretical speed of stator field and the rotor speed. It will be quite evident to the reader, that, as the speed of the rotor increases from zero, the rate at which the conductors are cut decreases, due to its catching up the speed of the stator field. Now, as pointed out before, the rotor speed at light loads is nearly the same as the stator field speed, and, if we load up the motor a little, it gives out extra power. To do this a number of things have to happen, *viz.*: first, the torque must increase; second, more current is required to produce the increased torque, which requires a greater e.m.f. to be generated in the rotor conductors; this means that the stator field must cut the rotor conductors at an increased speed. Now the speed of the stator field is a fixed quantity, because it depends on the frequency of the supply, which is unalterable unless we vary the speed of the generator; therefore, the only thing that can happen to satisfy the above conditions is for the rotor speed to drop, which is exactly what happens. It may be asked why the stator field strength does not increase, which would produce the effect required; but to answer this question would open a very big argument, and would necessitate comparison with a loaded transformer; therefore, we will take it for granted that the stator flux is, for our considerations, constant, and independent of the load; the only variation of the field strength is caused by volt drop on the windings, caused by the increased currents in same where load is applied; of course, this is not very great up to full load currents. Returning to our considerations, we had decided that the load when applied to a motor causes the rotor speed to drop; the amount of drop being governed by the load. This difference between the field speed and rotor speed is termed the slip of the motor; for example, if the field speed was 3,000 revolutions per minute, and for a given load the rotor speed was 2,900 revolutions per minute, the slip would be 100 revolutions per minute, or, expressed as a fraction of the field speed, the slip would be

$$\frac{100}{3{,}000} = \frac{1}{30} \text{ or } 3\tfrac{1}{3} \text{ per cent.}$$

(*To be continued*)

A Historic Site

It is probable that few among the throngs of people who daily pass the 31-story building recently completed at the northwest corner of Wall and Nassau Streets, opposite the Sub-Treasury in New York City, realize that its site is one of the most interesting historical spots in the country. A portion of it was occupied more than a century ago by a Presbyterian church which was used as a military hospital during the occupation of the city by the British.

In front of this lot there was a demonstration over the news of the battle of Lexington and the seizure of the City Hall by the Sons of Liberty in 1775. In the tavern of John Simmons, which was subsequently erected on the site of the church, a banquet was held in 1783 to celebrate the evacuation of the city by the British and the triumphal entry of the American army at which Washington, his officers and leading citizens were present. One year later in the same tavern James Duane, the first Mayor of New York, was inaugurated.

A Traveler's Tale

"Is it true, Mr. Romer, that you were once captured by cannibals?"

"Yes, I was on the bill of fare for a wedding banquet."

"Mercy! How did you escape?"

"Oh, the bride broke the engagement."

THE DIBBLE TRIPLE VALVE FOR RAILWAY TRAIN AIR BRAKES

O. J. GRIMES

As an improvement over the present method of controlling trains by air-brakes, a new triple valve is offered, supplanting the quick-action triple valve, and dispensing with the retaining valve.

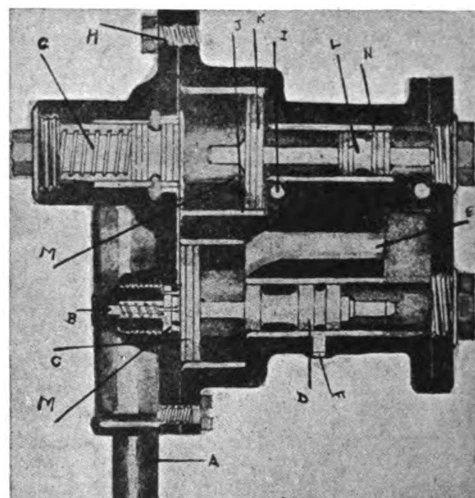
The numerous wrecks formerly due to loss of control of trains on heavy grades, when hand brakes alone were used, led to the invention first of the pressure brake, as now used on single electric cars, then to the vacuum brake, as adapted for train operation.

At first, the only way to recharge the auxiliaries after the brakes had been set, was to release the brakes; and the engineer having no control over the brakes during the period of recharging, runaways and disastrous wrecks were the results. Later, the device now in use, the retaining valve, was placed on the end of each car. With this attachment a pressure of 15 lbs. is retained in the brake cylinder while the auxiliaries are being recharged, but it is not controlled by the engineer and has been found deficient on steep grades. Many experiments have been made with the idea of overcoming these defects only to be abandoned as impracticable.

The inventor began work on his invention in 1900, but not until ten years later were his efforts crowned with success. Since then he has been adding new features and correcting small defects, and the device is now before the public for its inspection. With it in service the auxiliaries can be recharged at any time, placing the train in control of the engineer at all times.

The train-line pressure enters under both pistons and forces them to normal position. The release piston valve opens the exhaust port from the

and the hub on the lower side of the release piston seats on a gasket which covers about 1 sq. in. of piston, making it differential, and opens the vent port under the hub, releasing the air in the small chamber in the hub. The auxiliary piston moves down at the same time and admits air from the auxiliary to the brake cylinder, closing when the auxiliary pressure becomes a fraction weaker than the train-line pressure. The engineer now puts his brake valve in running position and charges up the auxiliary to normal. The release piston holds seat on



A. Branch pipe. B. Vent valve. C. Release piston. D. Release piston valve. E. Auxiliary pressure. F. Exhaust port. G. Emergency valve and spring. H. Emergency port. I. Port to auxiliary. J. Feed groove. K. Admitting piston. L. Admitting valve. M.M. Train-line pressure. N. Port from auxiliary to brake cylinder.

pressure

A STORAGE BATTERY HAND LANTERN

JAMES P. LEWIS

A storage battery flashlight, or lantern, designed to take the place of an ordinary oil lantern about the house is very useful and well worth the trouble of constructing.

The lantern shown in the accompanying drawing is but little larger than a large flashlight, and will give as much light on a single charge; the price for recharging being much cheaper than a new dry battery.

The cells, of which there are two, are carried in an outer case *A*, Fig. 1, of some hard wood, such as oak. This should be neatly and carefully put together with screws and glue, and afterwards varnished or polished, so as to

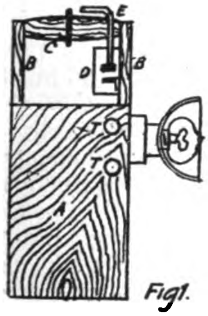


Fig1.

Fig2.

Fig3.

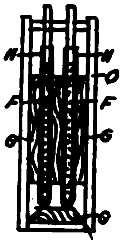


Fig4.

present a good appearance. The two end pieces should be left longer and cut to shape shown in Fig. 3. To form a support for the handle, about $\frac{1}{4}$ in. material should be used if the case is made say $2\frac{1}{2}$ x $2\frac{1}{2}$ in. by 4 in. high.

For each cell there are two plates (a positive and a negative), and they are held in separate containers inside the wooden case. These containers are made of $\frac{1}{8}$ in. hard fiber, the pieces being held together with a good tough cement aided by a few 2-56 machine screws. After the jars are finished, they are boiled one or two hours in melted paraffin to render them thoroughly acid-proof.

The plates are made as shown in Figs. 2 and 4 at *F*, each being a long strip of 1-25 in. sheet lead bent double, first punching them very full of $\frac{1}{16}$-in. holes. The $\frac{1}{8}$-in. space left between the sides of the plates is filled with a paste made as follows: Mix one part of sulphuric acid in 20 parts water. Use part of this solution to make a stiff paste with red lead for the two positive plates, and with litharge for the two negative plates. After the paste has hardened, rivet (using lead rivets) a strip of $\frac{1}{8}$ x $\frac{1}{4}$ in. lead, between the top edges of the plates. One end of each strip projects about 1 in., and is bent up at right angles so as to project through the end to form a terminal. The two open edges of the filled plates are now squeezed together with a pair of pliers, so as to prevent any paste from falling out. Small paraffined wooden strips *G* are used to wedge the plates in the cells, and to hold them apart and from the bottom. There should be about $\frac{1}{8}$ in. between each pair of plates. The lids are now cemented on with paraffin, a $\frac{1}{4}$-in. hole being bored in them to pour in the electrolyte. This hole is fitted with a soft rubber cork, which is removed when charging.

A 4-volt tungsten miniature bulb fitted with reflector is mounted on the outer case, also two binding-posts for connection when charging battery.

A good switch or push is made as shown in Figs. 1 and 3. It consists merely of a spring brass piece *K*, having one end secured to the base and the other carrying a contact which touches a contact *N* when spring is pushed down by rod *E*, which projects through the handle and is bent over at right angles on top. When a permanent contact is desired a ring on the handle *C* is slipped over the bent end of rod to hold same down. A small brass case *D* is made to inclose these switch parts, the main purpose of which is to inclose the tiny spark at the contacts when they are broken, so that the lantern may be used without danger around gasoline fumes, etc.

The electrolyte is made of six parts water to one of sulphuric acid.

The cells are connected in series and

(*Continued on page* 190)

WIRELESS AS AN AID TO SAFETY AT SEA

The advances made during the past five years in the application of wireless telegraphy have been remarkable, but in no direction have results so beneficial been achieved as in the marine field. Safety of ships at sea is a question upon which public attention has been focused since the loss of the *Titanic*. The advantages of wireless telegraphy for ship to ship, ship to shore, and shore to ship communication are obvious enough, and it is satisfactory to learn, says the *London Times*, that no rivalry between different systems will in the future prevent that free interchange of signals between ship and shore stations which is essential if the full benefits of wireless communication are to be assured to shipping interests. Nearly all passenger vessels now possess a wireless installation, either on the Marconi or the Telefunken system, and the number of shore stations is being rapidly increased. The latest phase of Marconi development is the agreement with the Government for a chain of wireless stations round the world on British soil. The existence of these long-distance stations should be of advantage to shipping interests.

Hitherto the ship installations of wireless plants have been almost entirely confined to war vessels and passenger steamers. The 1½ k.w. apparatus which is usually fitted in passenger ships is designed to have a large working range, and to be capable of being turned to various wave-lengths. The equipment of cargo steamers has hitherto been retarded by the absence of a sufficiently small, compact and efficient set, but there has been provided a ½ k.w. set which is specially adapted to the requirements of cargo vessels. This is a small power installation designed to produce transmitting waves of 250 to 600 metres, the transmitting range depending upon the height, length and shape of the aerial. The receiving apparatus provides for tuned reception of all waves between 250 and 1600 metres.

Another development of comparatively recent date is the wireless compass. The great development in the size and speed of modern ships has brought with it an increase of responsibility to those entrusted with their navigation. The need for a ready means of determining the position of a ship under all conditions has grown more urgent. It is claimed that the wireless compass is destined to prove an important new aid to navigation. It is not necessary to enter into the technical details of the apparatus; it will be enough to say that it does not give magnetic bearings, but positions with regard to the axis of the ship, which is determined by the magnetic compass. This being known, the wireless compass can be employed to give the position of the ship in relation to any shore station as well as the direction of an approaching or overtaking ship. The apparatus is designed to work with ship standard wave-lengths.

The great increase in the number of passenger vessels fitted for wireless communication—it is stated that 1000 were fitted in 1911 compared with 468 in 1910—is due partly to the initiative of shipowners, but is also to be attributed to the laws now in force in several countries which compel passenger vessels that carry more than a certain number of passengers to be equipped with wireless apparatus.

Almost simultaneously with the first application of wireless telegraphy to marine communication, the necessity, not only for the duplication of essential parts of the apparatus itself, but also for the provision of a source of electric current independent of the ship's dynamo, was foreseen, and special apparatus was designed for this purpose. This was over twelve years ago in the *Republic*. With engineroom flooded and all electric lights out, the wireless station was able to continue work for several hours by means of the emergency gear and call other steamers to her aid. Recently the principal powers have in their regulations made an emergency transmitting apparatus a compulsory part of a ship's installation.

A Storage Battery Hand Lantern

(*Continued from page* 189)

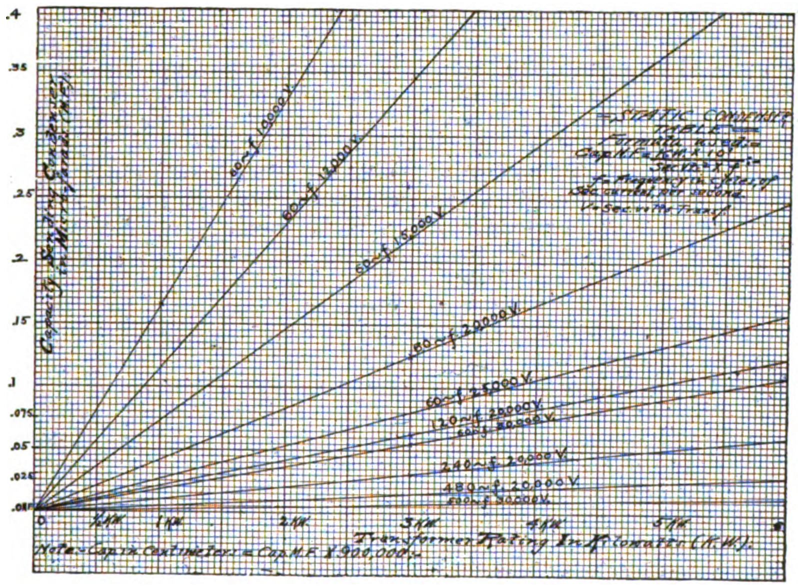
should be charged with 5 volts and ½ ampere for from four to six hours, a longer time being required for the first charge. Gravity cells may be used if no better source of current is available. They will hold the charge much better if the acid, lead, and paste are chemically pure.

SOME PRACTICAL HINTS ABOUT WIRELESS STATIONS

H. WINFIELD SECOR, A.M.A.I.E.E.

Now that the new wireless law has gone into effect, and the wireless industry, both experimental and commercial, has found itself, so to speak, the principal points to be watched in wireless plants will be, how to increase the efficiency with a given power, and how to have the station conform to the Underwriters' rules. Hence, the following may be of interest to those just installing or overhauling their stations.

A set of curves is presented herewith, enabling the proper capacity of transmitting condenser to be used with various voltages, and frequencies to be readily ascertained without any computations. Formulas have been given from time to time, in this and other periodicals, for calculating the capacity and dimensions of glass plate condensers for transmitters, and so I am not going to repeat them here.



A few figures on the capacity per unit area of active dielectric may simplify matters considerably, however, and the following value has been found by tests made for the author by Dr. A. N. Goldsmith, at the Radio Laboratory, The College of the City of New York.

The glass tested was an ordinary grade, and the value of the specific inductive capacity, or K, was ascertained to average 4.21 ± 0.02 at 5 volts, and 300,000 cycles frequency (1,000 meters wavelength), while at 50 volts and 60 cycles frequency K averaged 4.0 ± 0.2. The value of K thus found is of interest, as it is at these higher frequencies that the glass is used for transmitting condensers. The thickness of the glass tested was about 1.5 mm. or 1/16 in. nearly (.059 in. +). The capacity in microfarads (mf.) per 1 sq. in. of active air dielectric, 1/16 in. thick, is .000003596 mf., and for common glass similar to the above, the unit capacity per 1 sq. in. active area (covered on both sides by charging surface) is .00001513916 mf. for a thickness of 1/16 in.; and if the glass is ⅛ in. thick, the unit capacity per 1 sq. in. of active glass used, will be only one-half this value. The capacity is directly dependent upon the thickness of the glass; being higher for a decreasing thickness of dielectric, but of course the glass must be strong enough electrically to stand the charging voltage, or else it will break down or puncture.

The capacities of sending condensers required, as given by the curves here, are all right for fixed or quenched spark gaps; but for rotary gaps having a number of studs on them, the capacity may be

approximated by dividing the number of breaks per second, by 2, and using this factor for the value of *f*, in the formula given on the curve table. It is seen that the higher the voltage the less condenser capacity is required, and this varies inversely as the square of the voltage. The higher the frequency of the current charging the condenser, the smaller its capacity must be, or else it cannot become fully charged at each spark. For this reason an adjustable condenser is of great advantage in tuning up a transmitting set, especially where electrolytic interrupters or rotary spark gaps of variable speed are employed.

The connections of the transmitting apparatus are quite important, and are often overlooked by the experimenter. The primary wiring, supposing that commercial current from light or power circuits is employed to operate the transmitter, should be as carefully installed as all regular electric wiring, and if anything, more so. Copies of the Underwriters' Rules should be obtained from their offices in the larger cities. The primary wire should be rubber-covered, single braid if exposed, and double braid if enclosed; and flexible or rigid metal conduit may be used, or the wires can be run on porcelain knobs or cleats. Where the wire passes through any woodwork, or touches it, it should be encased in a porcelain tube in such a manner that the tube cannot slip away from its original location, and allow the wire to come in contact with the wood. Mount all the transmitting apparatus on hardwood strips or pieces of fiber, and these in turn on large porcelain knobs, so as to keep the high voltage current from leaking away, and thus lowering the working efficiency of the set.

The primary circuit of the transmitter should be provided with proper size and type of fuses, to protect the circuit against undue overloads, short-circuits, etc. The Underwriters' Rules require that the primary wireless circuit be protected against surges or kick-backs, by the connection of two fixed condensers, having at least ½ mf. each, in series across the primary wires, close up to the transformer terminals, with connection between the condensers grounded by an independent ground wire to the nearest water pipe or the station ground. A fixed condenser, having ½ mf.+ capacity, and easily made, may be composed of 1,845 sq. in. of .003 in. thick paraffined paper, coated on both sides with tin-foil. The paper should be about ½ in. larger all around than the tin-foil; and in this design, 16 sheets of 3½ x 35 in. tin-foil, with 15 waxed paper leaves between them, and one on top and bottom, and then the whole rolled up, have been employed.

It is well to use about 2,000 sq. in. of paraffined paper, as the thickness may vary, and also the tightness with which it is compressed. Every other tin-foil leaf is joined to a common terminal. A 5-ampere plug fuse should be inserted in series with each condenser, in case they happen to break down or short-circuit.

As is generally known the Underwriters require that the aerial lead-in wire and ground wire from the antenna switch or lightning switch shall be No. 4 B.&S. gauge copper at least, and while solid wire gives good results, much greater efficiency, both in the transmitting and receiving range, is noticeable if No. 4, or larger, stranded copper cable is used. This cable is best rubber-covered, but need not necessarily be. It should be run on large glass or porcelain insulators. The usual ground connection is on the street side of all meters, etc., on a water main. Failing this, an artificial ground must be formed; and one of the best, and at present used by the Federal Telegraph Co. at their large stations on the western coast of the United States, is the radial ground. This is formed of a number of radiating wires joined to one large conductor, and these wires are buried under the ground a few feet, but have been employed with the radial wires laying on top of the ground. For a small station, the wires may extend out 20 to 30 ft. or more from the central conductor. A dozen or so wires may constitute the radial system.

A good idea followed out by the Marconi Co., and others, is to provide choke or impedance coils at the secondary terminals of wireless transformers, to prevent the wasteful and dangerous surges from the condenser or oscillating circuit from backing up into the secondary of the transformer.

(*Continued on page* 197)

BECOMING A COMMERCIAL RADIO OPERATOR

Every summer a large number of students in the various high schools and colleges throughout the country find very pleasant occupation as radio operators on the vessels engaged in coastwise trade. A large number of extra ships are put into service, or are changed from freighters to passenger ships during the summer months, causing accordingly a great demand for radio operators. In the past the supply has nearly always equaled the demand, oftentimes surpassing it, but things have a different aspect this year. The new wireless law makes the number of cases where it is necessary to employ radio operators far in excess of what it has been in the past. At the same time the law has placed many restrictions on the class of operators that may be employed. Many wireless amateurs throughout the country who are considering entering this occupation next summer are inquiring as to what they must know in order to obtain the necessary federal license. With the view of answering these inquiries, we have compiled for our readers a set of questions such as are being asked at the examinations at the various Navy Yards.

Before giving this list, it might be well to consider the duties and the pay of a radio operator. The new law has caused many changes to be made in both of these. As far as they place restrictions on the operator his duties are defined in the text of the law. In general, however, the duties of a radio operator depend upon the kind of station he is placed in. There are two grades of commercial radio operators: a commercial first grade and a commercial second grade. As far as the exact statement of the law goes, the only difference between these grades is the speed of operating. A commercial first-grade operator must be able to receive and transmit in Continental Morse code at a rate of twenty words per minute, while a second-grade operator is only required to have a speed of twelve words per minute. This, however, is not the essential difference. Si-

had actual experience in wireless work, pirmarily in commercial work. This is done as a protection to those persons who make wireless their profession, and it is a just ruling. The larger steamers which take several days between ports have, for the most part, two operators, one of which is a first-grade and the other may be either first or second-grade. The first-grade operator is directly responsible for the care of the station and its instruments. The smaller steamers usually have but one operator, which in most cases is a first-grade. The operator in charge of the station is responsible for all of the wireless apparatus including the aerial, although the law is so framed that the company in whose employ the operator is, is required to furnish him with the necessary apparatus. He must take care of the motor generator set and the storage batteries, being able to make small repairs to either. Since he is employed by a wireless company, and not the steamship company, he reports any grievances to the wireless company. He is, however, subject to the orders of the commanding officer of the vessel in so far as they pertain to his duties as radio operator. In case the orders of the commanding officer conflict with his duties as required by law, he is to obey the law; and if the commanding officer refuses to permit the fulfilment of the law, the radio inspector should be informed at once on the docking of the vessel. Such circumstances as these are infrequent occurrences, yet they do happen. The commanding officer may request the removal of any unsatisfactory operator, and he may make any rulings regarding the operating room or the operators' quarters that he deems necessary. Where there are several classes of service, the radio operator usually takes his meals in the second cabin. On the whole the duties of a radio operator are light and pleasant.

Since the law has gone into effect various changes have been made in the wage scale. The scarcity of operators has

receive. It would vary very largely with the kind of vessel he got on. One company formerly doing business on the Atlantic coast paid thirty dollars a month and found. In addition to this, ten per cent. was allowed as a commission on all paid messages transmitted. This latter provision added very materially to the pay of the operators. Cases have occurred where operators on coastwise boats completing their trip in a day have cleared fifteen dollars on a trip, but these cases are exceptional and should never be relied on. Another company paid the operators in charge of ship stations eighty-five dollars a month and the operators in charge of land stations one hundred and fifty dollars a month. This scale has been somewhat reduced since the new law went into effect, because it has been necessary to employ two operators where one was sufficient before. The amount which an operator can make in the three summer months would probably vary from one to four hundred dollars. Of course it is understood that a new operator cannot expect to receive as much as an experienced operator.

After deciding whether or not a person wants to take up the occupation of a radio operator, either for permanent or for summer work, the next thing for him to do is to familiarize himself with the subject matter of the examination. He should be able to receive and transmit twenty-five words per minute, although the law only requires twenty. This would allow him a margin in case he made a mistake in the speed test. He should be thoroughly familiar with the new law and the Berlin Convention. If living near a seaport he should visit as many ship stations as possible because he will be required to state the types of apparatus with which he is familiar. He should be careful not to make any false statements in regard to the extent of his knowledge, because in the oral part of the examination he may be asked to describe anything which he claims to be familiar with. A thorough knowledge of some type of auxiliary set should be obtained, especially that part which deals with the storage cells. Great emphasis has been laid on this point. The subject of motor generator sets is taken up from a practical point of view rather than from a theoretical viewpoint.

When the prospective radio operator has satisfied himself that he can fulfill the requirements he should write to the examining officer of the nearest place where the examinations are held for Form 756. The places where examinations are now being held are: The Navy Yards at Boston, Mass., Brooklyn, N.Y., Philadelphia, Pa., Washington, D.C., Norfolk, Va., Charleston, S.C., New Orleans, La., Mare Island (San Francisco), Cal., Puget Sound, Wash.; at the Naval Academy, Annapolis, Md.; also at Fort Sam Houston, San Antonio, Tex., Fort Wood, New York Harbor, Fort Omaha, Neb., Fort Leavenworth, Kan.; at the Army stations at St. Michaels, Alaska and Fairbanks, Alaska; also at the Bureau of Standards, Washington, D.C. After filling out this form he should return it and await an appointment for the time when he may appear for his examination. When he goes to take this examination he is first given a question blank to fill out which requires information regarding experience and familiarity with radio apparatus. Besides this, information of a personal character is asked for. After this form has been filled out the written examination commences. The questions are passed out one by one, and no question is passed out until the one preceding it is finished. These questions are about all matters pertaining to radio telegraphy. After the written examination is completed, the speed test is taken, although in some cases this is left until last. Where it is taken in the middle, in some of the Navy Yards it is necessary to take a quarter of a mile walk between the building where the speed test is taken and where the rest of the examination is held. In this speed test five letters are counted to the word, deductions being made for running the words together. Numbers as well as letters are sent. When the speed test is finished, the examining officer asks several oral questions to which oral answers must be given. This part of the examination is divided into three parts: general knowledge of international regulations and Acts of Congress to regulate radio communication; the care of an auxiliary; general adjustment, operation and care of apparatus. Three separate marks are given for this part of the examination. When these ques-

tions have been answered. the examination is completed. About four hours is required for the entire examination. The time which the applicant has to wait before he is informed whether or not he has passed is anywhere from one to four weeks.

The type of questions that are being asked are given in the following list. Most of these questions have been taken from examinations given during the past month at the various Navy Yards. The list includes the oral as well as the written questions. It has not been an infrequent occurrence for the same question to be asked both on the written and oral parts.

1. What do you understand by the Berlin Convention?
2. Explain the method of calling a station and the form of transmitting a message as prescribed by the Berlin Convention.
3. What words are counted in giving the check for a message?
4. How are numbers counted in giving the check for a message?
5. What restrictions does the Act of August 13, 1912 place on radio operators?
6. What provisions are made for the secrecy of messages?
7. What is the fine for disobeying the regulation for the secrecy of messages?
8. What is the fine for disobeying the regulation regarding the sending of false signals?
9. What is the international distress call?
10. What wave-length must this call be sent on if it is possible for the ship to obtain that wave-length?
11. What would you do if you heard the distress signal?
12. If you were to send a distress signal and wanted some particular station to answer, how would you send the additional information and what would it consist of?
13. What wave-lengths are ships permitted to use?
14. What wave-lengths are reserved for government stations?
15. Upon what does the wave-length of an oscillatory circuit depend?
16. Suppose a transmitting station was emitting a wave-length of 300 meters, and the natural period of your antenna was 600 meters, how would you place your receiving set in tune with the 300-meter wave?
17. How would you measure the wave-length of your transmitting set if it was properly tuned?
18. How do you tell when your transmitting set is properly tuned?
19. How would you determine the natural period of your antenna?
20. How would you tell whether or not your aerial was radiating energy?
21. Give the formula for determining the wave-length emitted from a simple oscillatory circuit, considered to be made up only of capacity and inductance.
22. What relation exists between the frequency of a simple oscillatory circuit and its wave-length?
23. What is meant by electromagnetic waves?
24. What is their velocity?
25. What is meant by resonance between two circuits?
26. Where would you insert a loading coil in the receiving set and what effect would it have on the wave-length?
27. In a receiving set show by a diagram and explain what the difference between a tuned and untuned oscillating circuit is.
28. Describe a hot-wire ammeter and explain its uses in the transmitting set.
29. What are the uses of a wavemeter.
30. Draw a complete circuit diagram of a wavemeter and explain the principle on which it works.
31. If you increased only the capacity of the closed oscillating circuit of your transmitting set, would you change the emitted wave? Would your set still be in tune?
32. Draw circuit diagrams and explain the necessary steps to take in adjusting a transmitting set to a 300-meter wave-length.
33. Explain how you would change the wave-length of your transmitting set from 300 to 600 meters.
34. Explain what you understand between tight and loose coupling. Where does the division between them come?
35. What is meant by mutual inductance, and what effect has it upon coupled circuits?
36. What two forms of coupling are used in wireless, and what are the advantages and disadvantages of each?
37. What are damped and undamped oscillations, and the advantages and disadvantages of each?

38. Explain the meaning of the logarithmic decrement.

39. In the receiving set, what do the open and closed circuits include?

40. In an inductively coupled transmitting or receiving set, how does the energy get from the primary to the secondary circuit?

41. What is meant by a pure wave?

42. What are the advantages or disadvantages of a pure wave?

43. What does the new law say about pure waves?

44. What is a potentiometer used for in a receiving set?

45. If you should fail to receive any signals and you knew that they were coming, explain how you would test the various pieces of apparatus in the receiving set for faults.

46. If you knew that your receiving apparatus was all right and you still failed to receive the signals, what other tests would you make?

47. Explain how a silicon detector works.

48. If one of the condenser jars of the transmitting set became punctured and you did not have another to replace it with, how would you place your set in tune?

49. Draw a complete circuit diagram of a transmitting set from the direct current mains to the antenna, showing all switches and protective devices.

50. Describe the principal parts of the transmitting set, giving the uses of each instrument.

51. Describe three forms of condensers used in transmitting sets.

52. What is meant by a step-up transformer?

53. Describe an induction coil and explain the circuit diagrams in detail.

54. Describe and give the advantages or disadvantages of three types of spark gaps commonly used on transmitting sets.

55. What is meant by a synchronous spark gap. Explain its advantages.

56. What is the most common cause of the breaking down of high-potential condensers?

57. Describe the type of switch for changing from the receiving to the transmitting set that you are familiar with.

58. Draw a complete circuit diagram of a direct-coupled tuner and detector including the battery, potentiometer, and head phones.

59. Draw a complete circuit diagram of an inductive coupled receiving set, including one fixed and two variable condensers.

60. Explain the difference between a fixed, an adjustable, and a variable condenser.

61. Does it make any difference in the direction which the battery current flows through a carborundum crystal?

62. Name and describe four kinds of detectors.

63. What is meant by a rectifier, and why is it used in charging storage cells from A.C. mains?

64. Show how you would connect twelve Leyden jars so that there would be four in series and three in parallel.

65. What is an auto transformer and why is it used in place of an inductively connected transformer?

66. How would you locate a short-circuited field coil in a motor?

67. How would you locate a short-circuited armature coil in a motor?

68. Why is there a commutator on the motor and none on the generator?

69. What is the effect of changing the brush lead on the motor?

70. Suppose upon starting a motor generator set it refused to generate current, where would you look for the trouble?

71. Draw a circuit diagram of a differentially wound motor generator.

72. What is the advantage of using a differentially wound motor?

73. What would you do if the two field rheostats should burn out while you were at sea?

74. Explain the mechanism of the automatic break of the starting box.

75. How would you increase the voltage on the A.C. side of the motor generator set? Within what limits would you consider it permissible to increase this voltage?

76. Considering the brushes of the motor fixed, how would you increase the speed of the motor generator set without the use of a field rheostat?

77. What are some of the causes of sparking at the commutator?

78. How would you attempt to stop the sparking at the commutator?

79. Suppose that by some accident it was necessary to remove the connections to the motor generator set in order

to rewind a coil in the armature, upon starting the set again it was found that the armature ran backwards, how would you adjust matters so that it would again run in the right direction?

80. Suppose that the generator was wound for a frequency of 60 cycles, would it be possible to obtain 120 cycles from it at full load? Why? How?

81. Suppose that you decrease the current flow in the field coils of the shunt motor of the motor generator set ten per cent., what effect would it have on the speed of the set? Would the output vary?

82. What kind of current is supplied to the field coils of the motor of the motor generator set, and where is it obtained? What kind of current is supplied to the armature?

83. What kind of current is supplied to the field coils of the generator of the motor generator set, and where is it obtained? What kind of current is delivered by the armature?

84. Describe three protective devices that may be used in the motor generator circuit?

85. What is the cause of pounding in the motor generator set?

86. If by some accident the field coils of the motor should become demagnetized, how would you go about remagnetizing them?

87. Upon starting the motor generator set after you had found it necessary to take it apart for repairs, you should find that it was turning over at an excessive speed, where would you look for the trouble?

88. Assuming that the windings were designed for an overload current and that the insulation was good for an overload voltage, what would be the objection, if any, to running the motor generator set at a high overload speed?

89. In what cases is it necessary to employ a motor generator set?

90. Describe a lead plate storage cell with which you are familiar. What is the electrolyte used in this cell?

94. What is meant by the specific gravity of a solution, and what does it show?

95. Suppose that your cells should become sulphated, how would you remedy their condition?

96. When the solution becomes low in your cells, what do you add to fill up the cells?

97. Describe the new Edison storage cell, giving the positive and negative poles, also the electrolyte employed.

98. What is the voltage range of the lead storage cell? Of the new Edison cells?

99. Describe the underload protector used in charging storage cells.

100. Draw a circuit diagram showing the connections used in charging a storage battery. Mark the positive poles of the battery and of the generator. Include all protective devices and controlling rheostats. Show where the volt and ampere meters are placed.

Some Practical Hints about Wireless Stations

(*Continued from page* 192)

The author made some tests with such choke coils on an E. I. Co. ½ k.w. open core, 30,000 volt, transformer coils, in their Radio Laboratory; and with a coil composed of 8 turns of No. 4 B.&S. solid copper wire, having a mean diameter of 1¾ in., and turns spaced ½ in. apart, connected to each secondary terminal, the radiation current as indicated on a hot-wire ammeter was increased from 12 to 15 per cent. This shows that previously there was evidently a heavy surging from the condenser circuit back into the secondary of the transformer. The above test was performed with an electrolytic interrupter in the primary, and consequently the secondary frequency was very high, and the choke coils used were probably about right, but where 110 volt a.c. 60 or 120 cycle current and transformers are employed, these

QUESTIONS AND ANSWERS

Questions on electrical and mechanical subjects of general interest will be answered, as far as possible, in this department, free of charge. The writer must give his name and address, and the answer will be published under his initials and town; but, if he so requests, anything which may identify him will be withheld. Questions must be written only on one side of the sheet, on a sheet of paper separate from all other contents of the letter, and only three questions may be sent at one time. No attention will be given to questions which do not follow these rules.

Owing to the large number of questions received, it is rarely that a reply can be given in the first issue after receipt. Questions for which a speedy reply is desired will be answered by mail if fifty cents is enclosed. This amount is not to be considered as payment for reply, but is simply to cover clerical expenses, postage and cost of letter writing. As the time required to get a question satisfactorily answered varies, we cannot guarantee to answer within a definite time.

If a question entails an inordinate amount of research or calculation, a special charge of one dollar or more will be made, depending on the amount of labor required. Readers will, in every case, be notified if such a charge must be made, and the work will not be done unless desired and paid for.

1935. **Calibrating Ammeter.** J. A. E., Haddonfield, N.J., says: I am trying to find a way that can be used by amateur radio operators in calibrating a hot-wire ammeter accurately in amperes. Having made the wavemeter described in the September issue of your magazine, I am following up the same line of work on my own account. Since Ohm's law, I equals E/R, is not true for high-frequency currents (frequencies of near a million), how may it be changed to apply, or what law may be used in its place; so that, given any two of the three quantities, the third may be found? Ans.—Your case is that of many amateurs where it is impossible to obtain an ammeter to calibrate another instrument by. We do not see how it will be possible for you to calibrate your instrument unless you can obtain some form of a standard instrument. We could give you other methods but they would be more expensive than purchasing an instrument outright. Is there no laboratory where you could take it and get it calibrated? The assistants of college or technical school laboratories are usually glad to do such work at a small cost. Although the relation does not strictly hold, the more general method for calibration of hot-wire ammeters is to compare them with a standard meter on steady direct current. What you measure on the meter when used in connection with a wireless set is the equivalent heating effect as compared with unit direct current.

1936. **Dynamo Construction.** A. J. G., Hartford, Conn., says: I intend to build a dynamo that will generate 8 volts at 3,000 revolutions per minute. For the field magnet I have a field of a G.C. a.c. fan motor, on which I intend to put cast-iron extensions, as shown in the drawing. The machine is to have 8 brushes, shunt winding, and a rheostat between one set of brushes and the field. (1) What will be the size of the armature, number of slots, and where can I buy the stampings? (2) What will be the windings for this machine? (3) What kind of storage cells are there that are not in practical use? Ans.—(1) We presume you intend to have the cast-iron flanges match the 8 poles their entire length, though cased off with liberally rounded edges. If you have sheet iron only within the field spools, there will be no residual magnetism with which to enable the generator to start. The cast-iron extensions will hold sufficient magnetism. The 8 spools can be wound with No. 20 single cotton-covered wire, 24 turns per layer, and at least 7 layers—8 if possible. After winding two coils with 8 layers, try them on adjacent poles, and if they will go on without interference, wind all with this number. If there is difficulty in placing them, remove one layer. There will be no harm in having the spools with alternately 7 and 8 layers. The idea is to get on all the wire possible. For armature punchings you can correspond with the W. & S. Mfg. Co., Worcester, Mass., or F. E. Averill, Buffalo, N.Y. Perhaps the nearest size will be 3¾ in. in diameter, just the size of your field bore, and in that case you would need to bore the field space out about 1-16 in. larger. If you get punchings with an even number of slots or holes, the number should be divisible by 8. In this case you will have to adopt a "multiple" winding and employ 8 brushes, just as you propose. If you can get punchings with certain odd numbers of slots—those nearly divisible by 8—you may adopt a "series" armature winding, such as is common in railway motors, and use but two brushes, these being in your case 45 degrees apart; 25 slots will be a permissible number, and if you succeed in getting such stock we will be pleased to give definite directions as to the winding. Why not utilize the regular rotor punchings that belong with the present machine? They have an odd number of slots.

1937. **Aerial.** P. H. M., Beaver Dam, Wis., asks: (1) Would aerial as shown by sketch be satisfactory? (2) If it would not be a good aerial, would you please tell me how to make it so? (3) Would there be much induction from the electric light wires? Ans.—(1) Yes. (2) It would be better to use a single electrose insulator in place of the porcelain cleats. The additional cost of the electrose insulator is warranted by the increased efficiency. (3) The chances are that if any ground on the light wires occurred you would be troubled. It would be better to shift the antenna so as to have it at right angles to the electric light wires.

1938. **Electric Furnace.** H. F. D. S., New Haven, Conn., says: I have an electric furnace for the remelting of metals, in which I use a heater (carbon resister) in its well, and another carbon resister above the same for the actual work or the fusing of the metals by its generated heat, which is a success. Now, each of these resisters is directly connected by separate switches with the line provided with an intermediary rheostat to reduce the direct current of 50 k.w. from 220 volts to 110 volts in five steps. Now, under these conditions, can both resisters be operated together at the same time? The electrician making the switchboard and con-

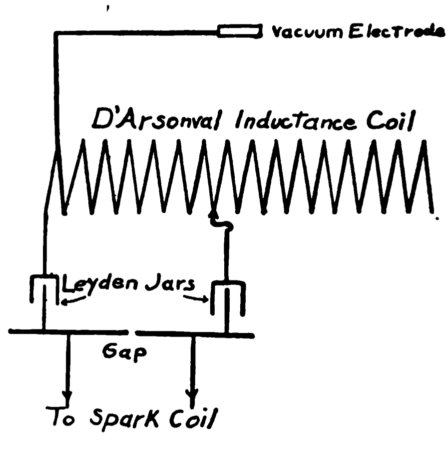
nections denies this and claims that the voltage would increase by one-half if both resisters were put into the circuit at the same time, and consequently make it inoperative. Is this correct? Ans.—As far as we can see your contention is correct, but we would be glad to see a diagram of the connections as provided by the electrician. Why not try the experiment? You have instruments and fuses in circuit, so as to note the result and prevent accidents.

1939. **Advisability of Patenting.** G. W., Canastota, N.Y., says: I have an arrangement by which I change a direct current to an alternating one to be used in a transformer. I just tried it tonight. I got a spark across the gap in an ordinary spark plug with about 12 or 15 volts in primary without the use of a vibrator. The article can be made for from about 5 cents each up. Do you think there would be any demand for an article of this nature that would be worth while getting it patented? Ans.—As you give no clue to the principle involved in the invention, we cannot undertake to guess whether it is valuable or not. Perhaps the idea is really an old one. Anyway, we would advise you to give the device a thorough test before spending any money. Try to operate it weak without stop and thus demonstrate what the test of time will do. Certainly if you can obviate the use of an interrupter you have a suspiciously good thing.

1940. **Rheostat.** X. Y. Z., Mattapan, Mass., says: Will you kindly tell me how to construct a rheostat that will cut 110 volts direct current to 10 volts? I wish to charge a 10-volt, 60-ampere-hour storage battery, but the ordinary 110-volt direct current is too strong for this purpose. Ans.—You do not state at what rate you wish to charge the cells, but we imagine 2 or 3 amperes will be proper. Incandescent lamps make about the best and cheapest sort of rheostat. Provide five or six "key receptacles" for standard incandescent lamps. Wire them together in parallel, in the ordinary manner. From your incandescent lighting circuit, lead one wire to one side of the row of lamps; from the other side lead a wire to the battery; from other side of battery lead a wire to remaining side of lighting circuit. Of course it would be well to provide a fuse cut-out, but the regular one in the distribution cabinet will suffice. Put 100-volt or 110-volt 16 c.p. lamps in the sockets, and by turning on more or less of them considerable variation in charging current will be offered, each lamp taking about one-half an ampere. If desirable to charge at a higher rate, 32 c.p. lamps can be used. To avoid running the lamps entirely at loss, they may be distributed in some otherwise dark corridor or basement, and by selecting the 100-volt sort, full candle-power will be realized. Of course the lamps should not be used when not charging batteries, for while they would give a fine light, they would soon burn out.

1941. **Voltage Regulator.** J. B., Bridgeport, Wash., says: (1) I have thought out a device which will automatically regulate the voltage on a lighting or power system. It is in the form of two plungers working inside of two wire-wound magnets and an arm is attached to a sliding bar on the current regulator. I want to know whether it is on the market or in use. (2) Cannot the telephone be arranged to ring the bell from the battery instead of using a generator to ring the bell, and have the bell ring by a push button contact in the battery circuit? Ans.—This idea is an old one, and in the past has been largely used, especially in connection with water-driven dynamos. The principal defect in the apparatus is that it is too sluggish or goes too far. It acts like a man "making" first base. He runs over. The name formerly associated with regulators of this class is Chapman, and probably no one has made a greater variety than he. We would advise you to consult the indexes of the electrical magazines of 15 to 20 years ago. At the present time the "Tirrell" regulator has displaced all other sorts. (2) Yes, house telephones, or those for short private lines, ordinarily utilize the batteries for ringing. In this case the bells are of the ordinary household type, fitted with make-and-break contacts, rather than of the "polarized" type, which operates on alternating currents only.

1942. **High-Frequency Apparatus.** L. H. B., Stockton, Cal., asks: Will you have the kindness to inform me whether there is any book published which gives practical working directions for the making of a d'Arsonval apparatus together with an Oudin resonator for generating high-frequency currents? If there is no such book or pamphlet printed, will you kindly advise me as to the best method of obtaining the desired information? Ans.—The June and July, 1911, issues of the *Electrician and Mechanic*, which



we can furnish for 15 cents each, contain a description of an Oudin resonator for the production of high-frequency currents. If you care for a more detailed description of apparatus for high-frequency work, we can furnish you with a book on the subject by Haller and Cunningham, for $1.25. In case you are going to use the description given in the above-mentioned magazines, the sketch will show you how to connect up for a d'Arsonval apparatus. The inductance coil is the primary described in the articles, but for this purpose it might be well to add a few extra turns to the number necessary for the primary of an Oudin resonator.

1943. **Mercury Interrupter.** P. E. R., Los Gatos, Cal., asks: How can I make a rotary, mercury interrupter that will break 25 amperes of storage battery current, with a frequency of about 200 sparks per second? Would a small metal wheel with four or six studs dipping into a cup of mercury be possible for such an interrupter? Ans.—A rotary, mercury interrupter to successfully break 25 amperes would have to be very carefully constructed. The arc produced at the break of a poorly-made interrupter would render its use impossible for wireless work. It is very hard to break the current quickly with a wheel having studs dipping in and out of mercury. The usual type of interrupter is the turbine type. It would be impossible to give a working description of such an interrupter in this column, but you will find a description of several types in "The Principles of Electric Wave Telegraphy and Telephony," by J. A. Fleming, pages 54 to 68.

1944. **Wireless License.** G. R., Springfield, Mass., asks: I have a set with an aerial about 100 ft. long and 30 ft. high. Receiving part only. (1) Is it necessary that I have a license for the same? (2) If so where is the nearest place I can get one? (3) Can I get it by mail? Ans.—(1) For receiving only you will not need a license for your station. (2) For New England the office of the Radio Inspector is at Long Wharf, Dept. of Labor and Commerce, Boston Mass. (3) Second grade operators' licenses may be obtained in this manner. For an operator's license apply also to the Radio Inspector at Boston.

1945. **Wave-length.** J. R. P., Grand Manan, Can., asks: With the help of the enclosed rough sketch, will you please determine for me (1) my wave-length; and how far I should be able to send; (2) Is my oscillation transformer constructed on the proper lines? (3) Please say if there are any alterations I can make that will improve the apparatus. The X marks the position of my station, and the surrounding hills are about 350 ft. high, wooded and about 2 miles from my station. With my receiving instruments I am able to hear Cape Cod, and by using an old telephone line for an extra aerial I can get Glace Bay very plainly. I would be very grateful for any suggestions you could give me that would improve my sending instruments. Ans.—(1) Local conditions make such a difference that it is impossible to give any data on wave-lengths or sending distances; still, from the dimensions given on your drawing it would be surprising if you could obtain a wave-length less than 300 meters. (2) Yes. (3) You might replace your stationary gap by a rotary or quenched gap.

1946. **Poulsen System.** C. E. W., Pikeville, Ky., asks: Will you give me as much information as possible on the Poulsen system of Wireless Telegraphy? (1) Can 220 volts d.c. be used instead of 550 volts d.c., and what would be the range of such a transmitting set? (2) Can an arc lamp run on 220 volts d.c. be used for sending? If not, what kind of arc can be used, and could you tell me how I can make one? (3) ... gram of both sending and receiving of this system. (6) Can d.c. be changed to a.c. when run through a rectifier? If so, give me a wiring diagram. (7) Can you tell me where I can get a book on Poulsen Wireless System? Ans.—In order to be fair to all of our subscribers it is necessary to limit the number of questions asked in any issue to three. You will see by reading the heading of this column that since you did not comply with the requirements of this department that your questions are not entitled to consideration, but as you have not taken your full liberty in the use of this department we will make an exception and answer your questions this time, but in the future it will be necessary to enforce the rule. (1) Yes. The range would depend on the other instruments used in the set as well as on the arc. (2) Not the regular carbon arc. It would take too much space in this column to even attempt to explain the Poulsen apparatus, but you will find several excellent photographs and a complete description of the construction and theory of this type of apparatus in the "Principles of Electric Wave Telegraphy and Telephony," by J. A. Fleming, which we can furnish for $7.50. (3) This is to increase the potential difference across the condenser. See the book by Fleming for a description. (4) Not that we know of. (6) No. (5) and (7) See book by Fleming.

1947. **Damped Waves.** L. L. R., Brookville, Pa., asks: (1) Kindly give me some rule or formula by which the frequency or number of sparks per second of a spark coil can be obtained. (2) Give rule for finding capacity of condensers, receiving and sending. (3) Explain damped and undamped waves. Ans.—(1) It is impossible to give any formula that one not well acquainted with high-frequency measurements could use. J. A. Fleming describes in his book on "Wireless Telegraphy and Telephony" a photographic spark counter devised by himself. In his description he gives the formula applicable to that particular counter. (2) In the March, 1911, *Electrician and Mechanic* you will find an explanation of the formula by which you can readily calculate the capacity of your condensers. (3) A highly or strongly damped wave is one in which the number of oscillations is small before the energy of the wave train is consumed. The greater the number of oscillations the less damped is the wave. The greater the value of the logarithmic decrement the more damped is the wave.

1948. **Wireless Telephone.** E. A. L., Sask., Can., asks: Where can I get reliable information about how to construct the best wireless telephone with earth or water connections in place of using an aerial, with diagrams of same? Ans.—You are evidently mistaken about the possibilities of using a wireless telephone without an aerial connection. If you were to connect the ground side to the ground and what is normally the antenna side to a water ground you would be grounding both sides. You cannot construct a wireless telephone that will cover any appreciable distance without using some form of aerial. We can furnish you

coils. Ans.—It would be much cheaper for you to read some book on the subject of spark coils and learn the complete methods of building a coil than for you to try to construct one on the small amount of information that we can give you in this column. If you cannot purchase a book on the subject in your own country, we can send you one if you desire. If you want to construct a coil without any further study we are glad to give you the dimensions for the size you desire. A 10-in. spark coil would be about the equivalent of a 1 k.w. transformer. This coil will not develop an actual 10-in. spark, but the output will be equivalent to one of that size. The core is 24 in. long by 3 in. in diameter. It is made up of soft iron wire of about 1/8 in. in diameter. The primary consists of two layers of No. 12 B.&S. gauge double cotton-covered wire. The secondary is made up of about 40 pies, each 1/8 in. thick, with an inside diameter of 3¾ in. and an outside diameter of 7½ in. For these pies about 15 lbs. of No. 28 d.c.c. wire will be required. The primary is insulated with a hard rubber of micanite tube. About 25 volts should be delivered at the terminals. If you use this coil on 110-volt mains it will be necessary to use a regulator, as the drop through the interrupter will not be sufficient to cut down the voltage to the desired value. To tune your set, first disconnect your ground and variometer, leaving just the primary oscillation circuit. Tune this circuit to the wave-length you desire by varying the condenser or the number of turns on the inductance. When you have a sharp wave-length of the desired value, as shown by the wavemeter, connect the ground and variometer, and by adjusting the variometer, tune until you get the maximum reading on the hot-wire ammeter and a sharp wave, as shown by the wavemeter. If you have done this carefully you should not have any wave that is stronger than 10 per cent. of the desired one.

1950. **Oiling Belts.** C. J. P., Columbus, O., asks: Please outline an effective process to drive oil and grease from old leather belts. Ans.—Certain oils are not harmful to belts, but if the size in mind is not too large we would suggest that you soak them in kerosene, and let them dry. Do not leave them in this condition, however, but proceed regularly to administer castor oil—the very best preservative yet known. It will contribute to frictional qualities, and give a fine black gloss that will refuse to attract dust. Further, the belts will be largely free from electro-static tendencies.

1951. **Transformer Construction.** L. O., Minneapolis, Minn., has made an experimental transformer, of best iron, stack of laminations being 1½ in. thick, and winding space on each leg 1½ in. x 1½ section and 9½ in. long. One leg is wound with four layers of No. 12 d.c.c. wire, taps being brought out at the 242d, 347th and 459th (last) turn. Other winding is on other leg, consisting of 18 sections of 2,000 turns ... wire. There is room be- ... primary cases? (4) Will a condenser be necessary? Ans.—(1) The tongue will be desirable, for its action or absence will enlarge the range of usefulness of the transformer. Without the tongue, the voltage regulation will be much better than with it, but for constant current experimenting, or even when desiring merely a choke coil, the presence of the tongue will make the apparatus more "fool proof." It will be well to have the secondary sections not permanently connected in series, but to leave them open in several places when experimenting with the other winding alone, thereby reducing the potential stress on the insulation. (2) 8 to 10 amperes. (3) Applying the 110 volts to the 232 primary turns, the secondary e.m.f. on open circuit will be about 17,000 volts; with 347 turns, 11,450 volts; with the whole 459 turns, 8,650 volts. Current should be limited to about .1 ampere. In consequence of the primary and secondary windings being on opposite legs, the regulation will be poor, that is, as soon as you try to draw current from the secondary, the voltage will greatly fall off. Lighting transformers always have primary and secondary windings equally divided on the two legs. In your case this was impracticable. (4) No.

1952. **Motor Winding.** E. E. H., Nazareth, Pa., says: I have several 12 in. fan motors, 125 cycles, 110 to 115 volts, 8 poles, a.c., built by the General Electric Company. Will you kindly advise me through your "Questions and Answers" Column if these motors can be changed so that they can be used in connection with 60 cycles, 110 volt, alternating current, and if so, how must they be changed to produce the maximum efficiency? Ans.—The eight field coils are connected so as to produce alternately north and south poles. To adapt operation to 60-cycle circuits, and yet get full speed, there should be but four poles. It will be a good idea to experiment on one of the motors by reconnecting the eight coils so as to get the effect of four poles, by having two adjacent poles alike, say north, then the next two south, and so on. The winding, however, will not be so effective as if you made entirely new coils of somewhat like twice the span so as to embrace two poles instead of one. For this new winding try one size smaller wire than that at present. These tests will not cost much, but will be instructive, and we, too, would be glad to learn the results.

1953. **Gear Calculations.** W. F. C., Fall River, Mass., says: Please enlighten me on the following questions: (1) Rule or formula for calculating the size of a gear (teeth, pitch, etc.); belts and shafting for transmitting a given horsepower. (2) What chemical is used for treating wood so that it will be fire-proof? Ans.—(1) The present accepted method of estimating gears is by the "diametrical" pitch, an expression that means a certain number of teeth on the circumference per inch of diameter. To take an example, a familiar case of railway motor gearing may be cited: the pitch is 3, that is, for

12 or 16, or even 24 should be chosen. To resume the railway reference, the gear on the axle has 67 teeth; its pitch diameter will then be 67 divided by 3, or 22⅓ in.; the pinion on the armature shaft has 14 teeth, its pitch diameter being, therefore, 14 divided by 3, or 4⅔ in. The outside diameter to which a gear blank is to be turned previous to cutting the teeth is of course larger than the pitch diameter, and the scheme of the diametrical method makes this determination very simple. Make a fraction of which 2 is the numerator and the pitch the denominator, and add this part of an inch to the pitch diameter and the result is the outside diameter. In the above cases the fraction will be ⅔; adding this to the figures given and 23 in. and 5⅓ in. are what the blanks should measure. The distance between the centers of gears for correct running is one-half the sum of the pitch diameters. In the above case the sum is 27 in., therefore the distance between center of armature shaft and center of axle should be 13½ in. A good rule for determining the size of a single-ply leather belt is to allow 1 in. of width per horse-power for every 600 ft. per minute of speed. Dynamo belts move much faster, but the proportion still holds. Thus, if power is to be transmitted between two 24 in. diameter pulleys running at 300 revolutions per minute, the belt speed will be about 1,900 ft. per minute, and 3 h.p. for every inch width of belt can be delivered. (2) Usually sodium silicate or tungstate.

1954. **House Lighting.** J. G., Baltimore, Md., asks: Can you kindly let me know how many 20 c.p. tungsten lamps the ½ h.p. dynamo in Mr. Watson's book will burn, and if I can get castings for same? Will it deliver the current for 500 yds., as I would like to build one of that size or larger for a water wheel to light our home. Ans.—The machine is liberally rated and can readily supply 400 watts for indefinite runs without undue heating, and 500 watts for limited "peak" runs—say, of an hour or so. Such a lamp as you mention requires about 25 to 30 watts, so you can operate 16 to 20 at once. Of course the house can be wired for a much larger number. 1,500 ft. is a long distance to transmit such a small amount of power, and we do not think the expense of the pole line and wires would be warranted. At any rate carefully compare the installation expense with that of driving the dynamo by a gasoline engine. Even if the expense of the water power utilization might be allowable you would still have to arrange for controlling the voltage. Excellent castings for the dynamo can be obtained by addressing the author through our office, and we would be pleased to advise you further with the project.

1955. **Motor Construction.** C. H. P., Elizabeth, N.J., has small motor parts that he would like to rewind, and run with about six dry batteries. The dimensions of field are 2½ in. bore, 1¼ in. long, with a single magnet core. The armature is of the laminated type, and is 1 in. thick and 2¼ in. in diameter. It has 12 ¼ in. slots. Commutator has six segments. Ans.—You must recognize that the motor cannot exert more power than is put into it, and that dry cells are but meager sources of energy. 1 volt pressure inefficient, the actual realization at the pulley would be less than one-half of this small amount. Even six cells would not exert enough power to hurt a person. If, therefore, you make the motor do any work at all, regard the result as a sort of triumph. If you wind armature with No. 23 wire and field with No. 20, all you can get on—you will get a good machine. The armature core should be a better fit in the field magnet, as long axially—1¼ in., and in diameter only 1-16 in. less than field bore.

1956. **Switches.** W. C. J. H., Manomet, Mass., asks: Will you please tell me where I can get diagrams of electric light switches for using different combinations and controlling lights from different points? Ans.—If you mean regular 3-point and 4-point "circuit" switches, you will find such regularly listed in the catalogs in any electrical equipment store. In the failure of such a search, we would advise you to address the Pettingell-Andrews Company or the Wetmore-Savage Company, both of Boston.

1957. **Motor Winding.** J. B., Worcester, Mass., has a "Knapp" 6-volt, 1-40 h.p. motor. The armature is made of punchings, and has its six slots wound with No. 28 wire, connected to a three-part commutator. The two field magnet coils are wound with No. 20. I wish to rewind this to give 6 volts and 1 or 2 amperes, speed about 2,200 revolutions per minute. Ans.—1-40 h.p. corresponds to about 20 watts, and at 6 volts the current would then be—assuming efficiency of motor at 100 per cent.—3 amperes. Such small machines never reach even to so high an efficiency as 50 per cent., therefore to get the rated horse-power you would have to put in at least 6 amperes. Now, No. 28 wire has a section of only 160 circular mils, and supposing the winding to be of the closed circuit order, 320 circular mils would represent the total current carrying capacity. While momentarily a current of several amperes might be tolerable, the regular capacity would not be over 1½ amperes. It looks, therefore, as if you could not with advantage wind the armature with any different size of wire. There would be a distinct gain, however, by rewinding so as to permit the use of a six-segment commutator. The field magnet should be shunt wound, and for this you should get on all the No. 30 s.c.c. wire possible.

1958. **Light from Sugar.** E. F. B., Sound Beach, Conn., asks: Why, when you break a lump of sugar or a wintergreen lozenge in a dark room, does it make a light? Ans.—The reason of the luminous accompaniment to the breaking of a lump of sugar in a dark room has been a subject of considerable discussion. The best opinion is that in the fracture of the crystalline structure of the sugar there is a molecular rearrangement involved which causes a disengagement of energy manifested as light.

1959. **Miscellaneous.** A. J. A., Milton, N.D., (1) What would be the best way to cover streaks on the inside of a mohair auto-top? The top has received the streaks from rubbing while folded together. (2) Could dye be put on with a paint brush? (3) Can as good pictures be

BOOK REVIEWS

Experimental Wireless Stations. Their Design, Construction and Operation, with particular respect to the requirements of the new wireless law. By Philip E. Edelman. Published by P. E. Edelman, 1912, and for sale by the Sampson Publishing Co., Boston, Mass. Price, $2.00 net.

It is not often that the experimenter entering a new field is given the careful attention that the wireless experimenter receives from this excellent volume. It is neither entirely elementary nor entirely theoretical. It is just what the experimenter has been waiting for. The author presents in a clear manner the fundamental principles of electricity and wireless telegraphy, giving actual examples of the use of the apparatus envolving the application of these principles in practice. In all cases complete dimensions for the construction of the various pieces of apparatus essential to a wireless station are given so that one reading the book is never in doubt as to how the described apparatus is built in practice. Supplementing these descriptions are several tables containing data for the construction of most of the common sizes of spark coils, transformers, and other common pieces of apparatus. Besides these are simplified formulas for the calculation of capacity, inductance, and other bothersome electrical quantities. Above all, the author is up to the minute, so that no experimenter in wireless can afford to miss reading this practical little volume.

Wireless Telegraphy and Telephony Simply Explained. A Practical Treatise Embracing Complete and Detailed Explanations of the Theory and Practice of Modern Radio Apparatus and its Present-Day Applications, together with a chapter on the Possibilities of its Future Development. By Alfred P. Morgan. The Norman W. Henley Publishing Co. New York, 1913. Price, $1.00 net.

A new book on wireless valuable for its clearness. The 150 engravings of sets in actual operation and wiring diagrams of these sets shown in perspective make this book well worth reading. In a simple—not too technical manner—the phenomenon of wireless telegraphy and telegraphy are so well explained that one reading the discussions should obtain a clear idea of the principles underlying the transmission and reception of wireless signals and speech. Each piece of apparatus used in a wireless station is completely described and in most cases illustrated by actual photographs of various types of the instrument. This book should prove valuable both for th[illegible]

Lessons in Wireless Telegraphy. By Cole and Morgan. Published by Cole and Morgan, New York, 1912. Price, 25 cents.

For the person who desires to take a glance into the art of wireless telegraphy it is hard to imagine where he could get more practical information for so small an expenditure than by the reading of this pamphlet. The complete subject as necessary for the practical operator or experimenter to be familiar with in order to construct and operate a set is treated in sufficient detail to enable him to get an excellent conception of the subject. The method of treatment is that of dividing the subject into thirty parts or lessons.

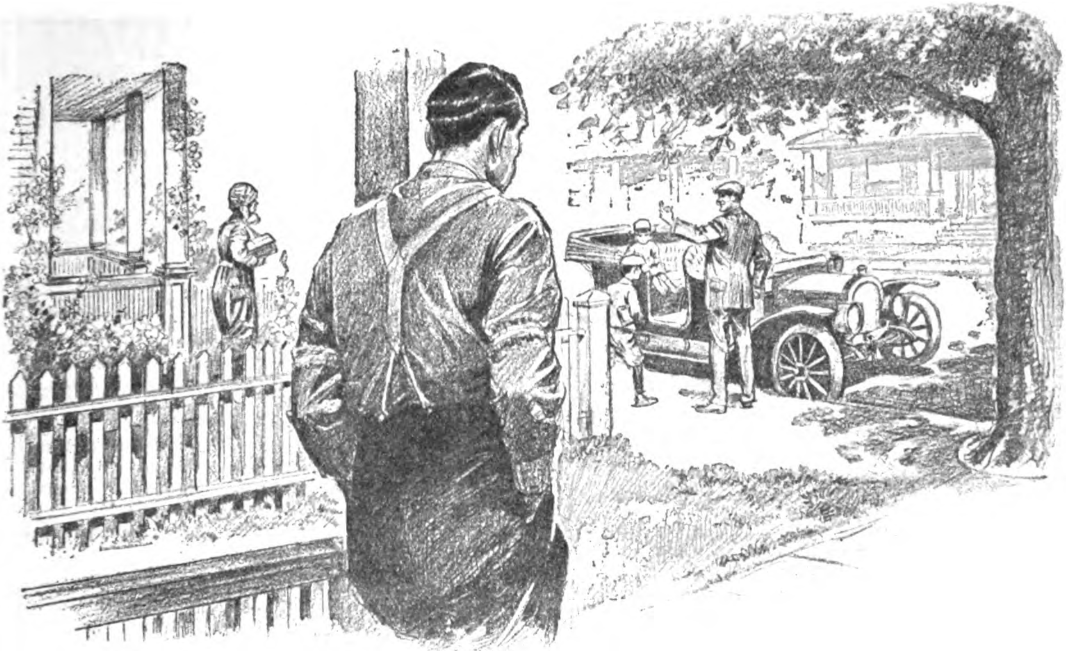
From Longmans, Green & Co., 4th Ave. and 30th St., New York, comes a catalog of Textbooks and Reference Books of Pure and Applied Science for Colleges and Technical Schools, comprising Agriculture, Architecture and Building Construction, Biology, Chemistry, Civil Engineering, Electrical Engineering, Geology, Manufactures and Industries, Mechanical Engineering, Mechanics, Pure and Applied, Metallurgy and Mining, Naval Architecture and Physics. This also will be sent on application to anybody interested in such books.

Twentieth Century Method of Squaring the Circle. By Harmon Evans. For sale by Abraham Sherman, 319 E. Fifth St., Dayton, Ohio. Price, $1.50. Postage extra.

This little pamphlet, containing a trifle over eight small pages of text, sets forth the belief of the author that the value of the ratio between the circumference and the diameter of a circle is 3.140625 exactly, instead of the well-known and definitely proved value which can be found in any mathematical text-book, and which has been computed to several hundred of places of decimals. The writer fails to give any proof, except his own belief in this figure, and his pamphlet is of no practical value to the mathematician.

From Norman W. Henley Publishing Co., 132 Nassau St., New York, we have received a copy of their Gasoline Trouble Chart, a sheet about 22 x 36 in., evidently designed for posting in the garage, which carefully classifies all possible sources of trouble in gasoline engines, and gives a large and carefully labelled sectional view of a typical modern gasoline engine. The information is valuable and is, in this form, rendered easily and quickly accessible to the mechanician. The price is 25 cents and our publishers will furnish it on receipt of remittance.

Indian Stories. By Major Cicero Newell.



WIRELESS TELEGRAPHY

In response to many requests, we publish below a list of books on wireless telegraphy, with the price at which we can furnish them, postpaid.

ASHLEY, CHAS. G., E.E., and HAYWARD, C. B.
Wireless Telegraphy and Telephony (Including Wireless on Aeroplane and Airship).—Contains 144 pages. Treats in a simple, concise manner earlier forms of wireless, electrical waves, development of radio-telegraphy, apparatus and systems. The section on Wireless Telephony covers Bell's radiophone, selenium cell, Bell's photophone, "light telephony," telephony by means of Hertzian waves, nature of a high-frequency telephone current, oscillation generators, telephonic control of oscillations, transmitting circuits, receiving arrangements, two-way transmission, and systems of radio-telephony, with a section on Aeronautics covering wireless on dirigibles, aeroplanes and balloons, dangers from electric discharge, preventive methods, wireless on the Zeppelins, Horton's experiments, recent records, and general problems. 1912. Cloth **$1.00**

BISHOP, LEON W.
The Wireless Operator's Pocketbook of Information and Diagrams.—Thoroughly describes latest transmitting and receiving instruments. 150 illustrations. All tables necessary for wireless operators, one showing how to compute roughly, sending and receiving distances. Full leather, flexible, pocket size **1.50**
Leatherette . . . . $1.25 Cloth **1.00**

COLE and MORGAN.
Lessons in Wireless Telegraphy.—For the person who desires to take a glance into the art of wireless telegraphy it is hard to imagine where he could get more practical information for so small an expenditure than by the reading of this pamphlet. The complete subject as necessary for the practical operator or experimenter to be familiar with in order to construct and operate a set is treated in sufficient detail to enable him to get an excellent conception of the subject. The method of treatment is that of dividing the subject into thirty parts or lessons. 1912 . . . . **.25**

COLE, A. B., and POWELL, A. M.
Amateur's Wireless Handybook.—The authors have reprinted the navy list of stations, and have Morse and Continental speed code charts. Book is filled with transmitting and receiving circuit diagrams, very useful to have on hand . . . . **.25**

EDELMAN, PHILIP E.
Experimental Wireless Stations, Their Design, Construction and Operation, with particular respect to the requirements of the new wireless law.—Contains 224 pages. Complete, concise, clear, understandable. Written by an experimenter who knows just what the readers want. The first book to give standard experimental designs in accordance with the new requirements. Contains full instructions for complying with the law, building and operating apparatus and stations, modern up-to-date instruments, simplified calculations, formulas and designs. A real "How it works and how to make it" book. 1912. Cloth, **2.00**

FLEMING, J. A.
Principles of Electric Wave Telegraphy.—A comprehensive digest of wireless telegraphy in all of its branches. One of the most complete and practical books ever published on this subject; new and enlarged edition **7.50**
Elementary Manual of Radio-telegraphy and Radio-telephony for Students and Operators **2.00**

HALLER, GEO. F., and CUNNINGHAM, ELMER T.
The Tesla High-Frequency Coil. Its Construction and Uses.—Full and explicit directions for the construction of . . .

HARRISON, NEWTON, E.E.
Making Wireless Outfits.—A concise and simple explanation on the construction and use of simple and inexpensive wireless equipments, for sending and receiving up to 100 miles, giving full details and drawings of apparatus, diagrams of circuits and tables. 12 mo. cloth, 50c; in paper covers . . **.25**
Wireless Telephone Construction.—How to make and use an inexpensive equipment. Cloth . . . . . **.50**
Paper . . . . **.25**

HOWGRAVE-GRAHAM, R. P.
Wireless Telegraphy for Amateurs.—A handbook on the principles of Radio-telegraphy and the construction and making of apparatus for long-distance transmission. 51 illustrations. Cloth. **1.00**

KENNELLY, A. E.
Wireless Telegraphy and Telephony.—Enlarged and reprinted. The whole story of wireless telegraphy from its invention to its very latest development, including the most complete and popular explanation of its underlying principles and their application **1.14**

MORGAN, ALFRED POWELL.
Wireless Telegraph Construction for Amateurs.—A manual of practical information for those who wish to build experimental wireless instruments which can be considered as something more than toys, but are still considerably less expensive than a high-grade commercial set. No attention has been paid to the history of the art, the space, instead, being devoted to short but complete explanations of the uses of the various instruments, as well as the structural details. 1910 . . . **1.50**

MORGAN, ALFRED P.
Wireless Telegraphy and Telephony Simply Explained.—A practical treatise embracing complete and detailed explanations of the theory and practice of modern radio apparatus and its present-day applications, together with a chapter on the possibilities of its future development. Has 150 illustrations of sets in actual operation and wiring diagrams of these sets shown in perspective. Each piece of apparatus used in a wireless station is completely described, and in most cases illustrated by actual photographs of various types of the instrument. This book should prove valuable both for the novice and to the experienced experimenter. 1913 . . . . **1.00**

PIERCE, GEO. W., Asst. Professor of Physics in Harvard University.
Principles of Wireless Telegraphy.—Just reprinted with corrections. The treatment of wireless telegraphy in this volume is strictly scientific. The book takes up the subject from the historical standpoint and develops each section of the art from its beginning to the present stage of knowledge. It shows fully why the earlier forms of apparatus in each instance have been discarded, and thereby enables the student to discover the merits which enabled present forms to survive. The chapters on detectors of all kinds are especially full and practical. While the book is not quite as full as Fleming's great manual, it covers all the points which the average specialist desires to know, and is an adequate presentation of the present state of the art. 1912 . . . . **3.00**

ROBINSON, Lieut. Com. S. S.
Manual of Wireless Telegraphy for Use of Naval Electricians.—An excellent, complete and instructive book for the wireless operator **1.50**

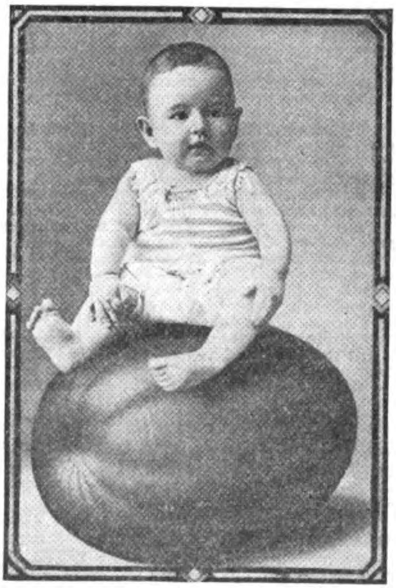
TESLA, N.
Experiments with Alternate Currents of High Potential and High Frequency.—A classic work . . . **1.50**

Reaping Rewards from Resolutions

By FRANKLIN O. KING

Do You Remember That Old Story about Robert Bruce and the Spider? Robert was Hiding in a Cave. His Enemies Had Him "In the Hole," Temporarily, So to Speak, As it Were. While Reflecting on the *Rocky Road* to *Royalty*, Robert, the Bruce, Espied a Spider Spinning His Web Over the Entrance to the Cavern. Nine Times Did the Spider Swing Across the Opening in a Vain Attempt to Effect a Landing, but the Tenth Time he Touched the Home Plate, and Robert, admiring the Persistence of the Insect, Cried Out Loud—"Bravo," Two or Three Times, One Right After the Other. Shortly After That Bruce Got Busy and Captured a Kingdom.

All of This Preamble is Intended to Point a Moral, which is—"If at First You Don't Succeed, Slap on More Steam, and Sand the Track." In This Connection I want to Inquire about Your New Year's Resolutions, and to Ask If You Have Kept the Faith, and If Not—Why Not? *I Believe the Pathway to Prosperity is Paved with Good Resolutions. Therefore let us Resolve, and Keep Resolving until Victory is Perched on our Banners.* Remember, You Have Fought Many a Victorious Waterloo that the World Knows Nothing About. The Man who Gets Up every Time He Falls Down Will Some Day Cease to be a "Fall Guy." *Good Resolutions Will Be Rewarded with Rich Realizations*, and It Shall Follow as the Night the Day.



How Much Better Off are You than Last Year, or the Year Before That? Perhaps Your Wages are a Little Higher, but Have not Your Expenses More than Kept Pace with That Increase? Aren't You Paying a Little More for Your Clothes and Your Meals, and don't You Smoke More Expensive Cigars and more of Them than Formerly? If it isn't Cigars, It may be Something Else—Some More Expensive Habit.

A Man Begins To Go Down Hill at Forty, and the time may come when a Younger Ma

Living, where they Snatch One Crop between Snowstorms and Blizzards, can soon Lay Up a Nice Bank Account in the **Winter Garden of America.** Come to the *Land of Least Resistance*, where You Can Grow Three Big Money-Making Crops a Year on the Same Soil and Without a Dollar's Worth of Expense for Irrigation or Fertilization.

I believe you could save Twenty-Five Cents a Day if You Tried. I know you would Try if you Realized that our Growers of Figs, Strawberries and Early Vegetables clear a net profit of $300 to $500 an Acre. Men have Realized more than $1,000 an acre growing Oranges in our Country. Remember that our Early Vegetables get to Northern Markets in Mid-Winter and Early Spring, when they command Top Prices.

One German Truck Grower on adjoining lands last spring realized nearly $500 from three-fourths of an acre of Strawberries. You could do as well if you only Tried, and on a Ten-Acre Tract **Find Financial Freedom.**

The Biggest Price paid for a car of watermelons on the Houston Market last year was $140. The car was shipped by the Danbury Fruit and Truck Growers' Association.

We are situated within convenient shipping distance of Three Good Railroads and in addition to this have the inestimable Advantages of Water Transportation through the Splendid Harbors of Galveston and Velasco, so that our Freight Rates are Cut Practically in Half. The Climate is Extremely Healthful and Superior to that of California or Florida—Winter or Summer—owing to the Constant Gulf Breeze.

Our Contract Embodies Life and Accident Insurance, and should You Die or become totally disabled, Your family, or anyone else You name, will get the Farm without the Payment of Another Penny. If you should be Dissatisfied, we will Absolutely Refund your Money, as per the Terms of our Guarantee.

Write for our Free book, which contains nearly 100 Photographs of Growing Crops, etc. Fill Out the Blank Space below with your Name and Address, plainly written and mail it to the Texas-Gulf Realty Company, 1462 Peoples Gas Bldg., Chicago, Ill. Read it Carefully, then use your

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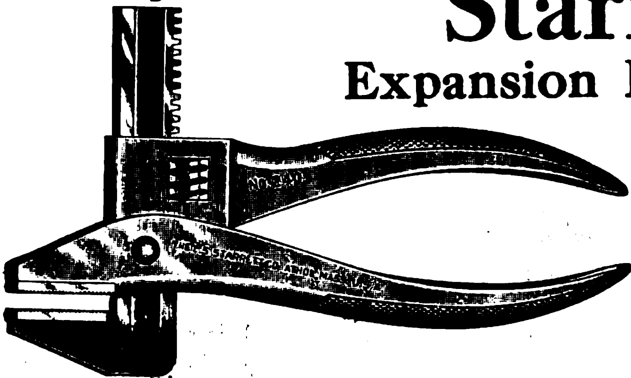

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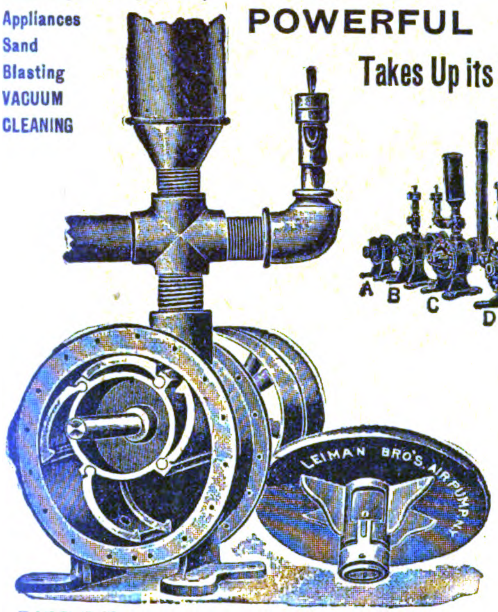

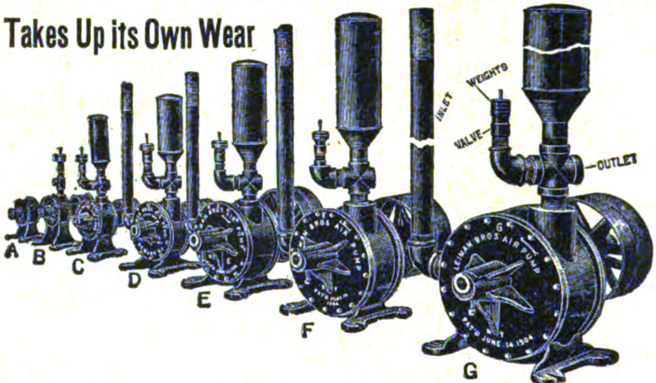

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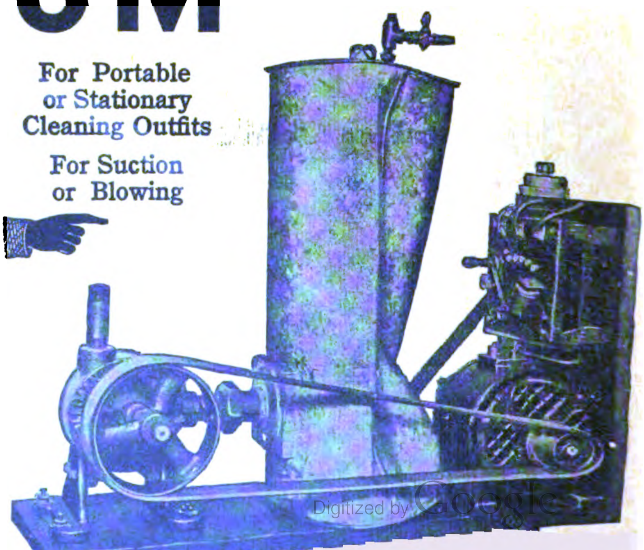

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20-inch, 10 pt. Cross Cut Blade

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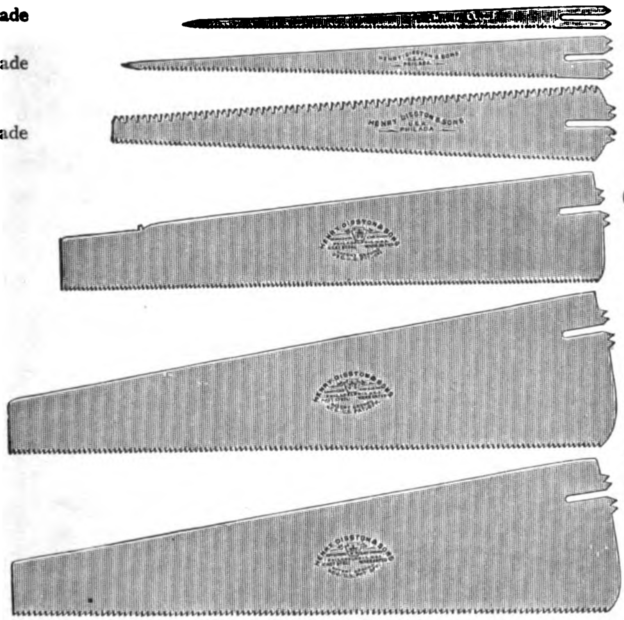

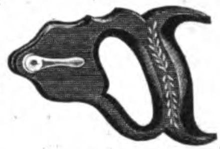

Adjustable Handle

The blades are fastened in the handle by a special lever device. It is arranged to take in blades of various thicknesses; the pin in bolt-head being moved forward or backward as may be required. This also permits the keeping of lever on a line with handle, so it will not interfere with the working of the saw.

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ELECTRICIAN & MECHANIC

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BENCH DRILL PRESS

LA ROSS VANDLING

It will be noticed in the construction of this machine that the counter shaft is independent of the base of the drill. This style of belting gives a more steady motion to the spindle and overcomes jars and jerks caused by unevenness of the belt. By running the belt moderately loose the strain of the belt is never on the spindle. Fig. 1 is the assembled machine. *A* is the feed lever, held to drill yoke by links *B*. The lug *C* is cast to the yoke to connect links. The spring *D* is attached to lever *A* and yoke *G* by means of two small eye-bolts. Two idler pulleys *E* run on shaft (not shown), secured and held in position by washer *F*. The drive pulley *H* and cone *J* are secured to drive shaft in bearing bracket *I*. Bracket *I* is screwed to base *S* with four 12-24 fillister head screws. The drill yoke *G* and base *S* are babbitted to standard *R* and held rigid with two setscrews in each boss. The standard *R* has a ½ in. hole tapped in the lower end for securing to bench. The arm *Q* slides on standard *R* and is secured by clamping bolt. The table *P* turns on arm *Q* and is also held rigid by clamping bolt. Spindle *O* runs in bearings *L* and *N* through pulley *M*. Pulley *M* has small key upon which spindle slides and is given rotary motion. The sleeve *K* is held to lever *A* by hardened pin. Two small set screws with hardened points are screwed partly through sleeve *K* into groove cut in spindle. The pins return lever to position when pressure is taken off of handle, assisted by spring *D*. A small fiber washer is placed between spindle and bottom of hole in sleeve. This washer is kept well oiled, as when in drilling the pressure is on the end of spindle and washer. The drill end of spindle is to be fitted to the drill chuck, which latter

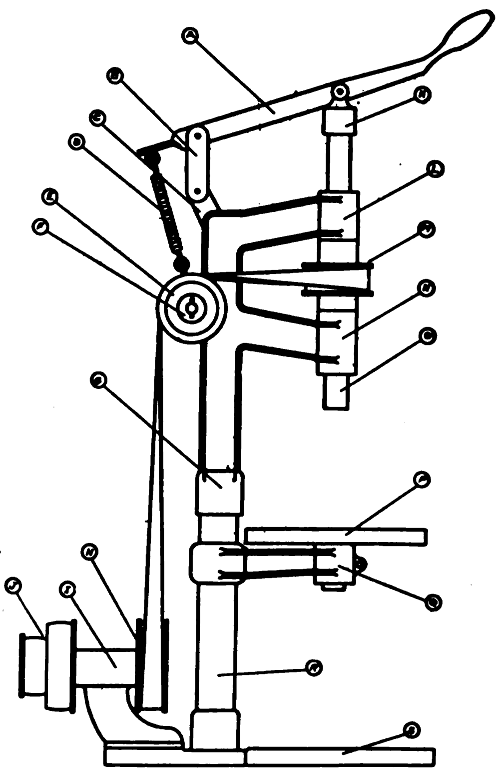


Fig. 1

can be purchased at almost any price —$3.00 to $5.00. Get one capacity of 0-¼ in. While this range, 0-¼ in., is not the drill's maximum, it is well not to go beyond it, as the speed that the press requires for the smaller drills would prove disastrous for larger ones.

The castings from Fig. 2 to Fig. 6 are all of iron and patterns will be required for these, as well as for Fig. 9 to Fig. 12 inclusive. Great care should be exercised in placing cores in Figs. 2, 3, and 4, as room for ⅛ in. of Babbitt-metal

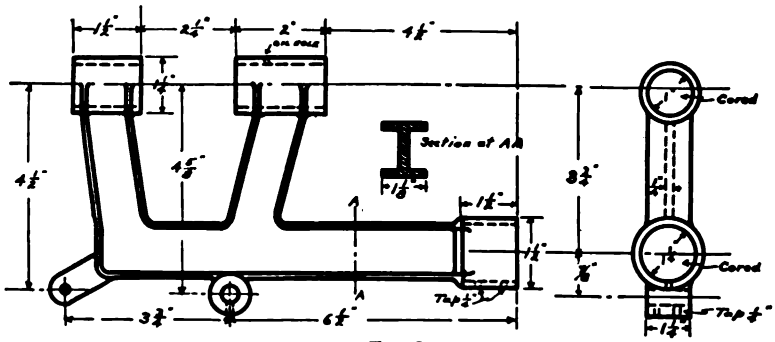


Fig. 2

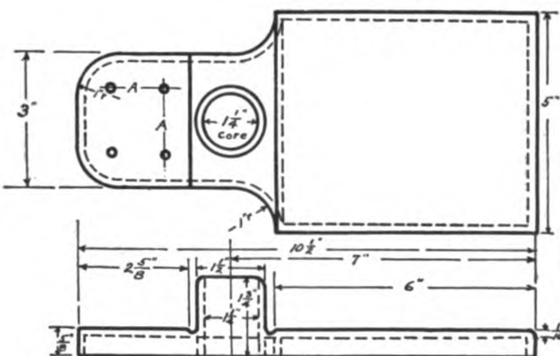


Fig. 3

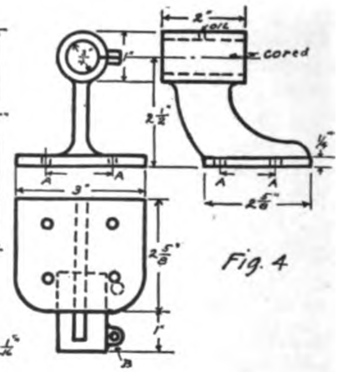


Fig. 4

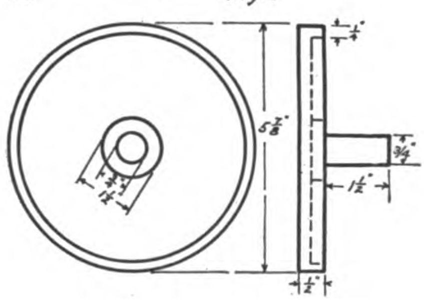


Fig. 5

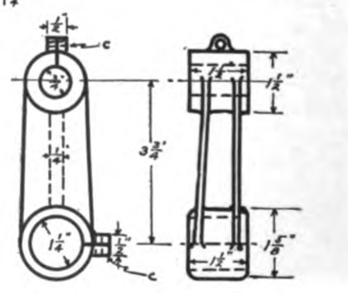


Fig. 6

should be provided, and if in the patterns the core prints are carelessly placed, the castings will not "line up." There is very little machine work on Fig. 2, the ends of the boss for the idler pulleys and slot for feed lever links being all that is required, and this can be done with a file, but care should be taken to get both sides parallel. Fig. 3 is the base and is faced top and bottom. The top of boss has just enough stock taken off to make it straight with the planed surfaces of the base plate. Fig. 4 is faced on each end of the boss and on bottom which sets on base. Four holes are drilled, a body fit for 12-24 screws. Fig. 5 is the table and is finished all over. Fig. 6 is the reach arm and has the two holes drilled and reamed. It is then split through clamping lugs, and clamping bolts made and put in place at *C-C*. Fig. 7 is the spindle, the distances at *C* and *D* are not determined until machine is being erected. Fig. 8 is the standard and is made from a piece of 1¼ in. cold drawn steel, centered perfectly true and the ends turned down. The pulleys are turned and cut within as shown by dotted lines to decrease weight, flanges being turned about 1-16 in. thick and face of pulleys given a good crown. In making pulleys, do not forget the one for the counter shaft. The sleeve, Fig. 15, is turned from brass and is good fit on the spindle.

ERECTING

In these instructions for erecting, reference will be made to Fig. 1 unless otherwise noted. After necessary holes have been drilled and tapped for bearing bracket *I*, place the base on a level part of the bench and place the long end of standard in the cored hole of the boss. Line the standard perfectly true with the planed surface of the base, insert the set screws until they just touch the end of standard. Having secured it in true alignment by means of clamps, turn it upside down, and having sealed up all cracks with putty or clay, pour babbitt in the space between standard and boss. Now set it in its original position and tighten up set screws. It would be best to file a flat place on the standard where the set screws come in contact, blind set screws being used for this purpose, as they give a better appearance. Now take the yoke casting and babbitt it in the spindle. To do this, place the pulley *M* on the spindle *O* and see that there is 1-16 in. space between the pulley hub and bearings on each end. This space becomes filled up with babbitt in pouring, and acts as thrust surfaces for the pulley *M*. In babbitting this the spindle should be flush with the top bearing and the long end towards the base of the machine. It is best not to use the spindle for this operation, as the keyway may give some trouble in babbitting. Before placing in position to babbitt, give the ¾ piece a good coating of white lead, as this will help greatly when removing it from the

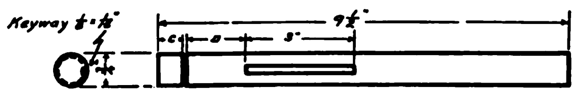


Fig. 7


Fig. 8

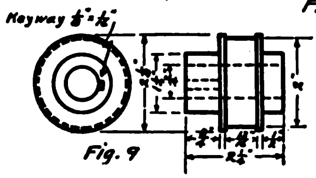


Fig. 9

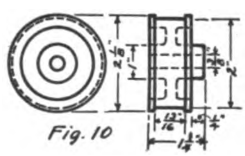


Fig. 10

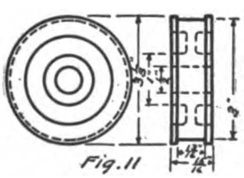


Fig. 11

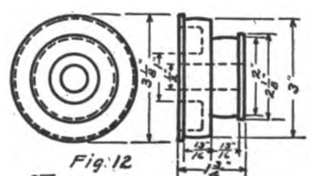


Fig. 12

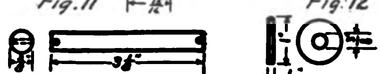


Fig. 13

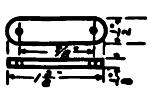


Fig. 14

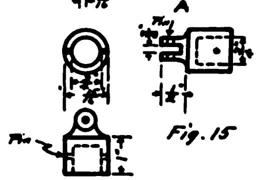


Fig. 15

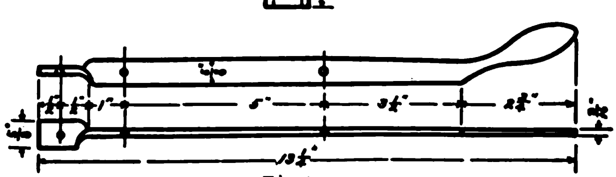


Fig. 16

yoke. After drilling the necessary holes for pouring, also a vent hole, seal up as in the above mentioned case and pour in the babbitt. Now do not remove, the ¾ in. arbor for the present, but leave it in the yoke. Now place the arm *Q* permanently on the standard *R*, and clamp it to standard in a central position with the base. Insert the ¾ in. piece that is still in the yoke in the remaining hole in *Q*. Bring it down in position and evenly divide the clearance of hole in the yoke and the standard. When this is accomplished tighten the set screws in the yoke against standard end, tighten clamping bolts on *Q*, seal and babbitt. Tighten up set screws and remove ¾ piece in yoke. Be careful that the casting is not sprung in doing this, as you will find the rod pretty tight in bearings. Work it out a little at a time by means of a lathe dog attached to one end and worked out by twisting. Babbitt up the bracket *I* and screw in position. The shaft for this bearing is not on the drawings, an ordinary piece of the required size of steel is all that is needed. Drill an oil hole in bearing, place the pulleys on shaft and secure with set screws. Screw the bracket on the drill base and the lower part of the machine is completed.

Place the shaft for the idler pulleys, Fig. 13, in the boss on the yoke and secure with two set screws. The pulleys are a running fit on this shaft, and have a washer and pin on one side. Washer is shown as *A* Fig. 13. Do not forget to drill an oil hole in each pulley. Get a good running fit in the spindle bearings, and have the keyway cut in spindle in such a manner that when spindle is at its highest position there will be 1 in. of keyway in the pulley and 2 in. on the feed lever end of spindle. Get a good sliding fit on the key in the pulley. This key is held in pulley by two small screws. The feed lever parts are now to be connected and the machine is now ready for use. Some of the friction on the feed end of the spindle can be eliminated by substituting a pivot for the washer joint, or one that is still more elaborate having ball bearings and two hardened collars between the sleeve and spindle. Though more expensive at first, this method of caring for the thrust will pay in the end.

The groove cut in the end of spindle is 1-16 in. x 1-16 in. and is V shape and the screws that run in this groove are placed in such a manner that no pressure whatever comes on them, their only purpose being to assist in returning the feed lever to its upright position.

Now by giving the castings a good painting of flat black you have a machine that is good looking as well as very sensitive and accurate enough for almost any class of small drilling.

A stud is screwed in the tapped end of standard, long enough to reach through bench and give room for a nut and washer. Be sure that the base is setting on a level surface before tightening to the bench. As in the installation of all small machinery, it is preferable to place the counter shaft under the bench and use a long belt. In this machine the pulleys are for a ¾ in. single flat belt. Do not attempt to sew this belt, but make a good scarfed and glued joint, and before putting on belts give them a good dressing of castor oil to make them pliable and take out the natural stiffness.

Fire Engine Used to Thaw Cable Ducts

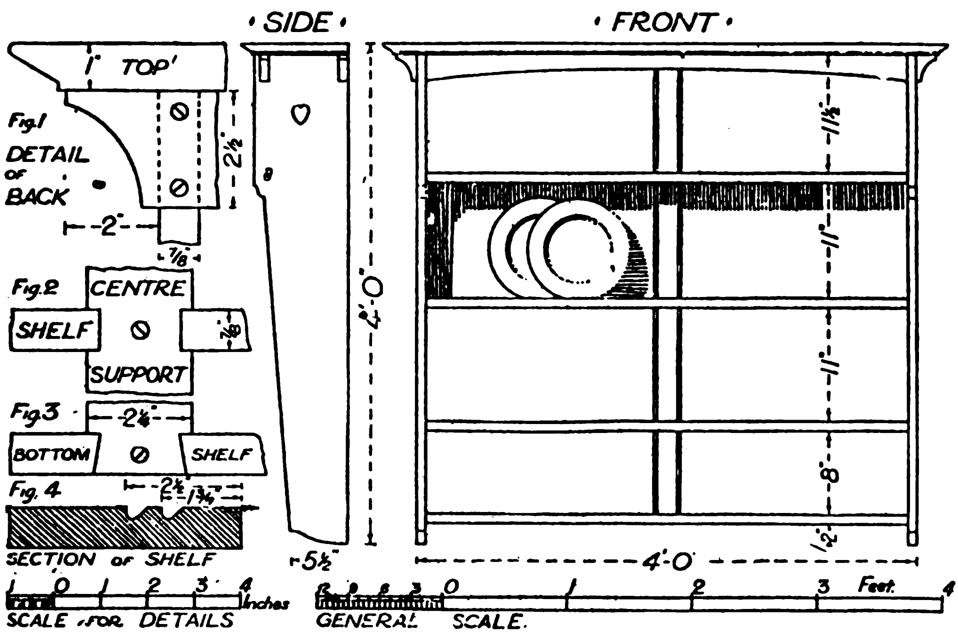
In a western city last winter it became necessary to pull some cable from a dozen blocks of underground duct which had frozen up as a result of the severe weather. The old cable was in cement-lined conduit which had been in the ground for a number of years and was badly out of alignment. Mud and water had collected in the depressions and, solidifying, held the cable fast. Several methods of melting the ice were suggested, the first plan proposed being that of sending a heavy current through the cable and sheath. It was feared, however, that the lead covering might be damaged by this procedure, so that the use of steam heat to melt the ice was decided upon. A fire engine was borrowed from the city department and stationed over the first manhole outlet, a hose from its steam line being led directly into the cable duct. With this equipment an average of a 300-ft. block was freed each day, so that the job was completed in about ten days. The engine was moved from day to day, the old cable being pulled out as rapidly as the ice was melted and new conductor drawn in in its place.—*Electrical World.*

A SIMPLE HANGING DRESSER

P. R. GREEN

The accompanying drawings show a design for a simple hanging dresser of elementary construction. Although it does not offer the accommodation usually provided in the serviceable but rather ugly kitchen dresser, yet it will be found to be a useful substitute in cases where the erection of the ordinary type of dresser is impracticable by reasons of economy and space. If constructed of 1 in. prepared deal, or of whitewood, it may be painted and finished in white enamel, or, as an alternative, staining dark bronze green and varnishing gives a pleasing finish.

the sides. Fig. 1 shows how the back rail is screwed flush to the back edges of the sides. The same figure shows a detail of the solid molded top which finishes 4 ft. 6½ in. by 10¼ in. by 1 in., and is secured by screwing down to both the rails and the sides. A 2¼ in. by ⅝ in. center support is notched and screwed into the back edges of the three upper shelves, as indicated at Fig. 2, and a dovetail joint is used at the bottom shelf, Fig. 3. The center support is also halved and screwed to the back rail and to the back edge of the top.



The front and side elevations show clearly the main dimensions and construction. Two sides, each 3 ft. 11 in. by 9 in. by ⅞ in., are diminished to 5½ in. wide at the lower ends, and housed (preferably with stopped dovetail grooves) to receive the four shelves, spaced as indicated on the front view. The sides are connected at the top by two curved rails, each 4 ft. 4 in. by 2½ in. by ⅞ in., the ends of which project 2 in. beyond the sides, the front rail being set back ½ in. from the front, and either nailed or screwed and neatly plugged to

Fig. 4 gives a detail of the grooves that are ploughed in the shelves to prevent the plates from slipping forward, this arrangement being neater than the somewhat clumsy method of nailing fillets. Two grooves are shown, to accommodate different sized plates, but in the bottom shelf the back groove only need be cut. The grooves are easily worked by ploughing from the back edge and finishing with round plane to a depth of about ¼ in. The dresser should be fixed with the top about 6 ft. 9 in. high.—*Carpenter and Builder.*

MECHANICAL DRAWING

P. LEROY FLANSBURG L. BONVOULOIR

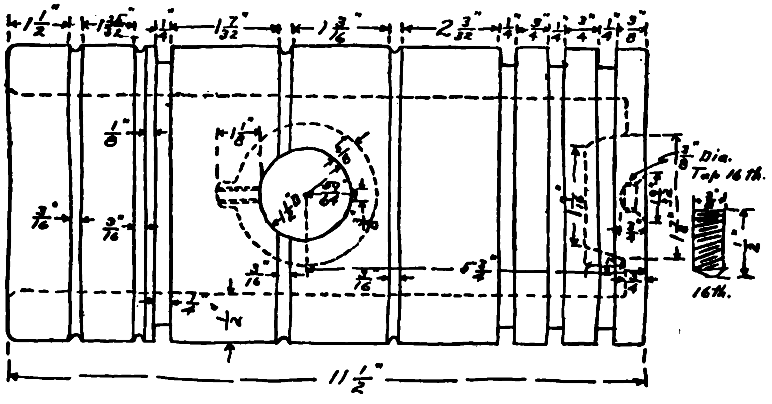
SKETCHING EXERCISES

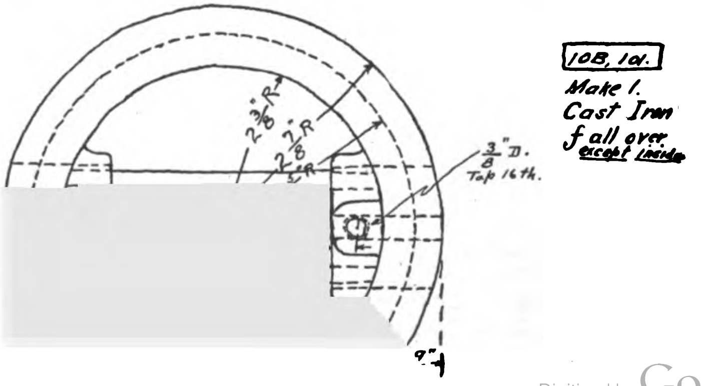
Fully Dimensioned Details

Generally, the objects of which drawings are to be made are located some little distance from the drawing room, and for this reason the ability to make quickly a neat, freehand sketch is one of the most important requirements of a draftsman. Not only must the sketch show all of the details of the object, but it must also be fully dimensioned in order that all subsequent work may be made entirely from the sketch. Since it is possible to acquire skill in freehand sketching only by persistent practice, it is best to do all machine sketching strictly freehand.

In making a drawing from a sketch an accurate idea is obtained as to the actual shape of the object, and the increased ease and facility with which a drawing can be read more than compensates for the additional labor required. This is especially true in the case of a complicated object.

It is best to always sketch such views





of the object as will give the greatest amount of information.

When it is desired to show the internal structure of some object or mechanism it is often necessary to pass one or more imaginary planes through the object at the desired place and then construct a view which will show the object as it would appear if all that part of the object in front of the plane or planes was removed. Such planes are called section planes and are quite largely used in Mechanical Drawing. An example of their use is in the case of the sketch or drawing of a symmetrical piece. In this case, it is of no advantage to sketch both halves alike, since the duplication of the work gives no added information. Instead, one-half of the object may be sketched as an outside view, while the other half of the object may be shown in section. The outside view of the object may be with or without dotted outlines or partial sections which show some internal part not elsewhere shown. The sectional view will always be so taken to give the maximum amount of information regarding the internal construction of the object.

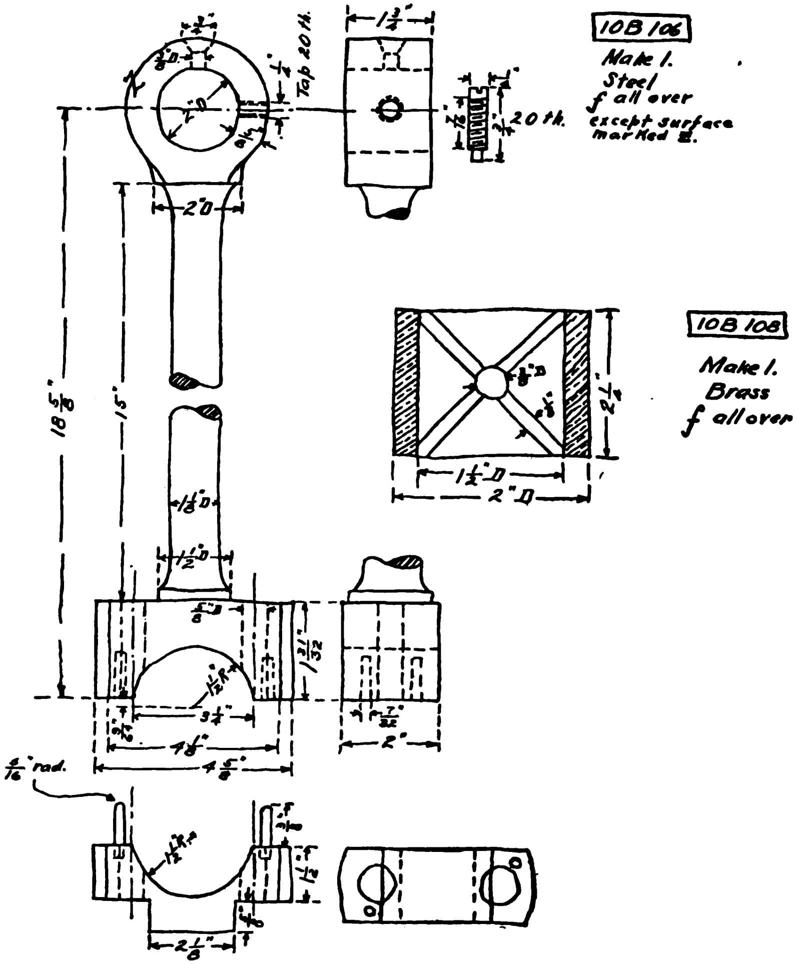


Fig. 2

All lines used in freehand sketching, both curved and straight, should be continuous, comparatively smooth, and distinct.

When more than one set of views of an object are placed upon one sheet of paper, they should all be so arranged as to be read with the paper in the same position. All views must be made sufficiently large as to permit of complete, readable di-

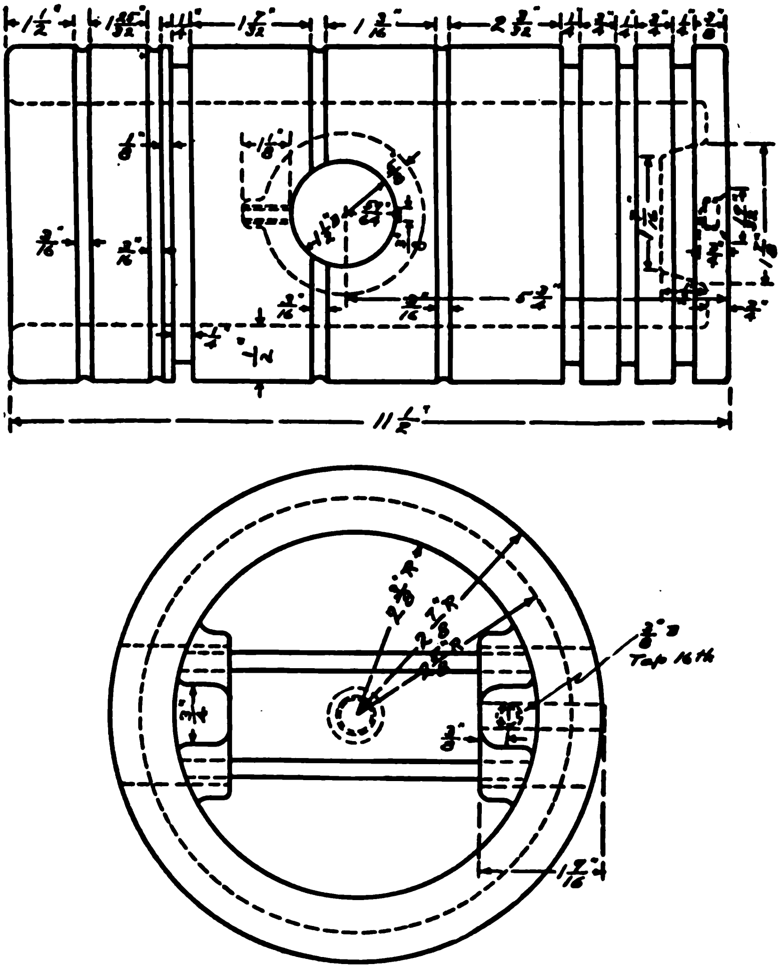


Fig. 3

mensioning, and each piece and part of the object must be sketched separately.

It is always best to draw center-lines whenever possible; and this applies not only to complete views, but equally so to every symmetrical portion of every view.

After making a sketch the object sketched should be considered with reference to finished surfaces, and such surfaces are indicated on the sketch by placing a small letter *f* across each line, which represents a finished surface in the view of the object where this surface appears as an edge.

In dimensioning a sketch, always give a complete series of successive dimensions and also the over all dimension for the series. Never measure a dimension from an unfinished surface, and if it is impossible to give a dimension which can be taken directly, be sure to record all dimensions from which the required dimension has been calculated.

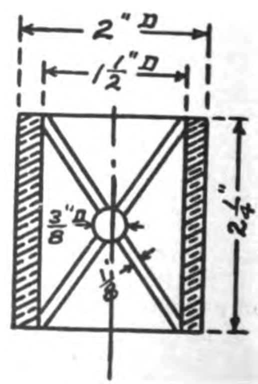


Fig. 4

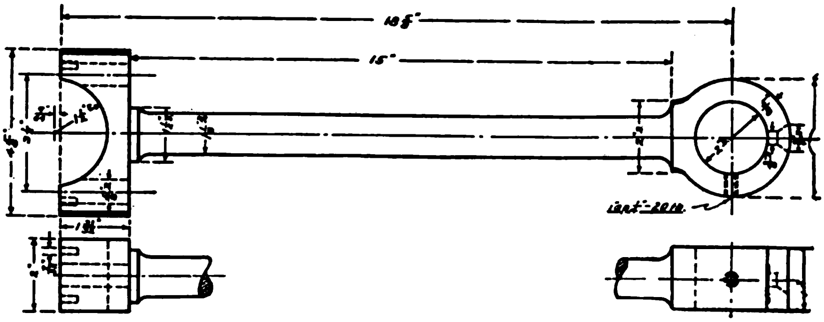


Fig. 5

The drawings which accompany this article will give some idea both of sketching and of detailing.

Fig. 1 is a sketch of a gas engine piston, showing the location and size of the piston ring grooves, oil grooves, etc. No attempt has been made to draw absolutely straight lines and the drawing is a good example of the type of work met in actual practice. It will be noticed that in dimensioning arcs the dimension is followed by the letter *R*, showing that the dimension is a radius. In the case of a tapped hole the size of the drilled hole and also the number of threads per inch on the tap are given. A small table is placed at one side of the drawing, and this contains any information which may be desired about the object.

Fig. 2 is another sketch, and one which shows some interesting points. It should be noticed that when cylindrical surfaces are shown without end views, the letter *D* or the abbreviation *Dia.* follows the dimension figures. 10*B*, 108 shows a sectional view of a brass bushing.

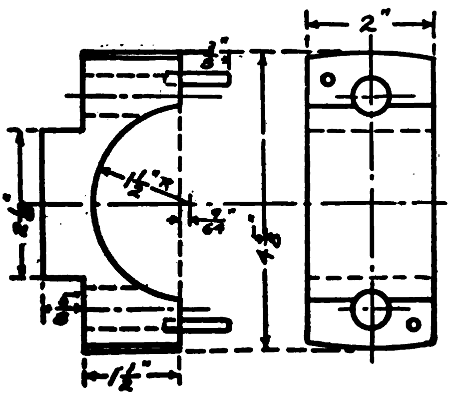


Fig. 6

After making the sketch of the object, the next thing to do is to make a detail drawing from the sketch. This drawing should be scaled, and after the pencil drawing is completed a tracing should be made of the drawing.

Figs. 3, 4, 5 and 6 are detail drawings. When the detail drawings have been completed they are used in making an "assembly." An "assembly" is a drawing which shows the completed object or mechanism, and these drawings will be described in the next issue of the *Electrician and Mechanic*.

Aluminium Paint

The following, taken from *Mechanical World*, may be of use to some readers requiring to mix their own aluminium paint. It is made from powdered aluminium, and contains about 91 per cent. of metallic aluminium, 6 per cent. of aluminium oxide, 1.5 per cent. of silica, and 1 per cent. of water. The powder is made by forcing gas or air under pressure into the molten metal at the time of setting, this being accompanied by vigorous mechanical stirring. The granulated metal thus formed is partly oxidized, and is easily pulverized in stamp mills, after which it is run through sieves and then polished in polishing mills. The powder is then mixed with a varnish of the following composition: Turpentine, 1.5 gal.; palest copal varnish, 0.5 gal.; palest terebine, 4 oz.; magnesium carbonate, 4 oz. The magnesia is allowed to settle, and the clear varnish is then drawn off. About 2 lb. of powder are mixed with 1 gal. of varnish.

PANELING—WHAT IT IS AND HOW TO DO IT

Paneling in the ordinary sense, consists of a comparatively stout framing filled in with thinner wood, which, breaking up the level surface, gives a more or less good effect as compared with a flat surface without any break. It may be formed by a great many methods. We may have sham paneling and real paneling, plain and molded, flat and raised, and so on almost indefinitely. Therefore, we propose to show in this article how the various kinds of paneling are formed, and the places and positions for which they are most suitable.

There are certain purposes for which soft wood is preferable to hard; and also where the reverse is the case, and where it is almost imperative that hard wood be used. These will be pointed out as we proceed.

In Fig. 1 we show the elevation of a paneled dado, made in the plainest possible style; one which lends itself to sham work, the difference in the real and the sham being almost impossible to detect. As for this purpose the sham is quite as good as the real, we will make a start with a description of this sham paneled dado.

Provided that the walls are straight and square, the making of this will be easy, all that is required being to board them up flat with a thin board and then fix the framing, consisting of the stiles, *A*, the rails (bottom and top) *B*, and the muntins, fitting and fixing them in the order given. The first lot of boarding will then, of course, form the panels.

Vertical sections on lines *A* and *B*, respectively, are shown at Figs. 7 and 8, and a horizontal section on line *C* is given in Fig. 4. If this kind of paneling is to prove successful, it is necessary that the joints in the "panels" should come

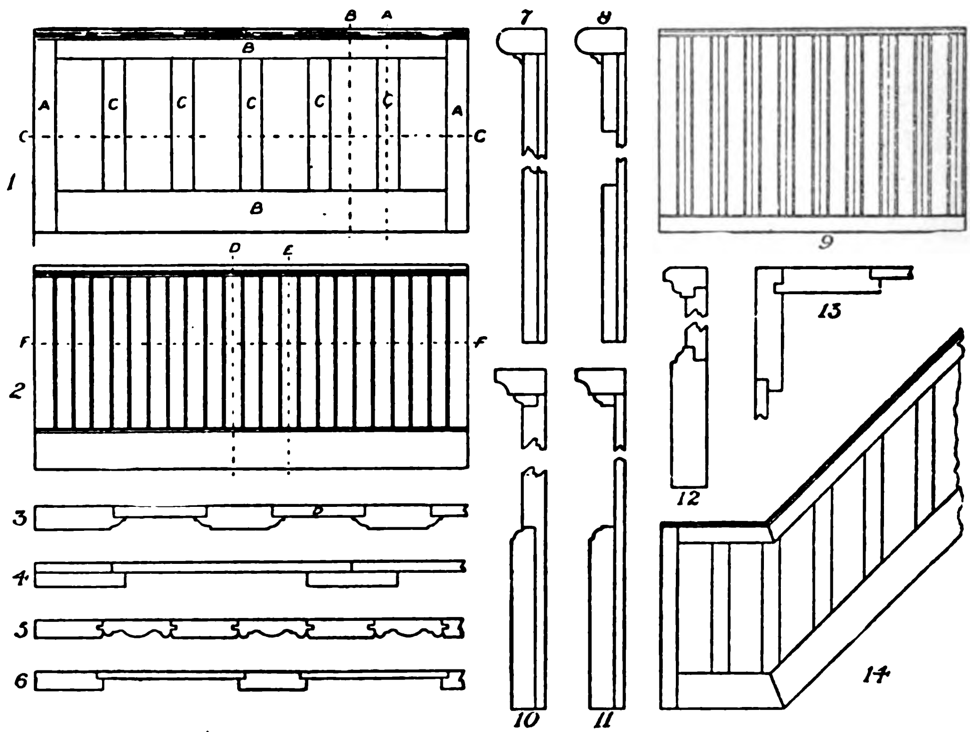


Fig. 1.—Elevation of Plain Sham Paneling. Fig. 2.—Elevation of Moulded Sham Paneling. Fig. 3.—Section of Fig. 2 on line FF. Fig 4.—Section of Fig 1 on line CC. Fig. 5.—Horizontal Section of Fig. 9. Fig. 6—Alternative Section for Fig. 1. Fig. 7.—Section of Fig. 1 on line A. Fig. 8.—Section of Fig. 1 on line B. Fig. 9.—Another Style of Plain and Moulded Paneling. Fig. 10.—Section of Fig. 2. on line D. Fig. 11.—Section of Fig. 2 on line E. Fig. 12.—Vertical Section of Fig. 9. Fig. 13.—Joining Paneling at Right Angles. Fig. 14.—Staircase Dado in Sham Paneling.

so that the muntins will cover them, as in Fig. 4, and to attain this end the wood may have to be cut up into irregular widths. The panel boards must also be of even thickness throughout, and must be fixed very firmly; screws should be used for preference, and the wall should be plugged. If care is taken that all the screw heads will be hidden by the stiles, rails, or muntins, there will be nothing unsightly about it when finished.

The wood which will form the framing must be even in thickness, also gauged accurately to the widths required and the edges planed quite straight and square. All the parts will then bed together as though they were one solid whole. However truly the framing is planed to thickness, there will be a certain amount of inequality at the joints; these must therefore be planed off after the paneling is finished.

The bottom rail should always be wider than the other framing. Double the width, as shown in Fig. 1, is as a rule correct. The stiles, muntins and top rail should all be the same width, and in making paneling which comes together at the corners, either internal or external, the stiles should be so arranged that they appear of equal width when finished. Thus, in fitting to an internal angle, one stile must be the thickness of the paneling *wider*, and for an external angle one must be the thickness *less* in width. For ordinary paneling 4 in. will be found a suitable width for stiles, rails and muntins, the bottom rail to be as wide again, and the panels to show some 8 or 9 in. wide according to the way they space out.

While we are on dado work, we will show another kind of sham paneling which has a good appearance and is very easily made and fixed. The elevation of this is shown in Fig. 2, and sections on lines *D*, *E* and *F* are given in Figs. 10, 11 and 3 respectively.

In this style, narrow panels as *D* are fixed to the wall at intervals as required, muntins should be shouldered so that the plinth will come as Figs. 10 and 11.

The procedure in fixing this dado is: First, the panels, which must be correct in width and thickness; then the muntins, which must be rebated to fit the panels and shouldered all alike to take plinth and capping; then the plinth; and lastly the capping. Or the above may be varied by fixing the plinth next after the panels *D*, following on with the muntins.

Yet another style, easy but effective, is shown in Fig. 9, the horizontal and vertical sections being as Figs. 5 and 12. Here the plinth is rebated at the back, and the boards forming the paneling proper are shouldered so as to fit down behind, as in Fig. 5. They are also cut at the top, so that the capping will fit onto them in the same way as the plinth. As a rule this is all the fixing required.

As the horizontal section, Fig. 5 shows, the panels are really tongued and grooved boards, plain and molded being used alternately. This method will be found a ready means of forming a cheap and effective dado.

Fig. 6 shows an improvement on Fig. 1. The effect as regards the appearance is the same, but the actual result is much more workmanlike and satisfactory, while the labor and materials required are very little more.

Sham paneling lends itself particularly to staircase dados, as Fig. 14; an effective dado being formed far more easily by this method of building up than in making the actual paneling. In the latter case beveled work is not easy, but in the former there is little difference whether square or beveled.

Fig. 13 illustrates the necessity of having one stile wider than the other for internal angles, and also shows a good method of fixing them together at the corner. The tongue and groove keep each piece in its proper place, which is sometimes rather difficult with a plain joint.

using if made in hard wood. In the latter case the grain should run vertically at the face. In the former it is immaterial which way it runs, but it is very important that, whether the hard wood faced or the alder throughout is used, it must be of good quality, otherwise there will be trouble with blisters.

If the wall where the paneling has to be fixed is inclined to be damp, it must either be treated with a damp-proof solution, or three-ply wood should not be used. Although supposed to be waterproof, it is not fair to put it to too severe a test in this respect. It will stand anything in reason if of good quality.

We will now take into consideration paneling proper, in which the framing is real and the panels genuine and not merely a background throughout. The framing is, as its name implies, framed together with mortise and tenon joints, the panels fitting into grooves made for them in the various parts of the framing; if done properly they will fit so closely into the grooves that they will form as it were one solid whole.

The simplest form in which real paneling can be done is the rectangular frame, filled in with a single panel, such as we see in cupboard and wardrobe doors. This we will pass over as being almost too simple for our purpose, and consider something with more work in it and requiring more skill to set out and construct. This we find in the paneling shown in Fig. 1, and even this we have divided into two portions, the one having two panels only in height, while the other has four smaller ones. Simple as even this is, both in theory and practice, the probability is that the majority of carpenters or joiners would, in working it, fail to make all the joints fit—this for a reason which we will give later on.

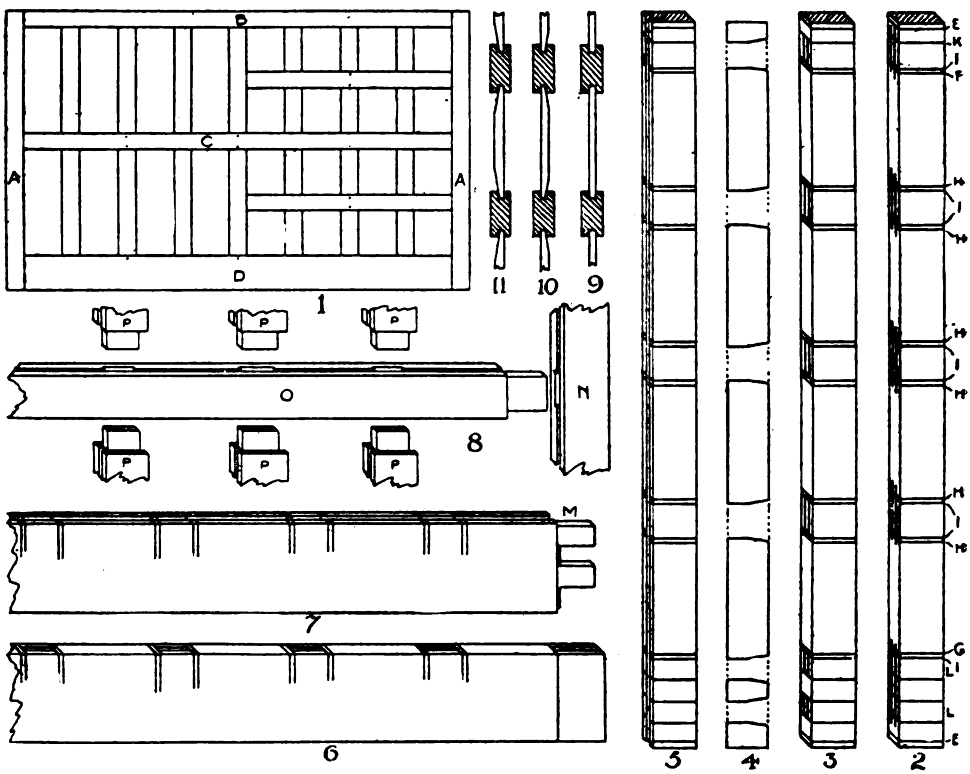


Fig. 1.—Elevation of Paneling (two treatments shown). Fig. 2.—Stile set out for mortising. Fig. 3.—Stile mortised. Fig. 4.—Section through Stile, showing "Wedging-in" mortises. Fig. 5.—Stile grooved for Panels. Fig. 6.—Bottom Rail set out and mortised. Fig. 7.—Bottom Rail mortised, grooved, tenoned and haunched. Fig. 8.—Portion of Panel ready for putting together. Fig. 9.—Section of Plain Panel. Fig. 10.—Section of Mulleted Panel. Fig. 11.—Section of Simple form of Raised Panel.

It will be noticed that the horizontal

pieces of the framing are continuous from stile to stile, and that it is the vertical parts which are cut to fit between. This is as it should be in most cases, though there are exceptions which must be treated on their merits. In all ordinary cases the worker should follow out the rule that stiles (outside vertical pieces) should run from top to bottom, all rails (horizontal pieces) should be continuous from stile to stile, and the muntins (inside vertical pieces) should be cut between the rails.

This rule then necessitates that the stiles will require mortising to take not only the top and bottom rails, but the intermediate ones as well, no matter how many of these there are. The rails will need tenoning at the ends to fit into the stiles, and mortising to take the muntin, the top and bottom on one edge only, the intermediate on both edges. This means in most cases that the mortises will be made quite through the rails. The muntins will be tenoned on both ends to fit into the rails, some of the tenons being long enough to be pinned, the others being shorter. Should pins not be allowed for fixing, the tenons may be secret wedged (to be explained later); in any case the tenons which come to the stiles should reach through the latter, and they can then be wedged up in the usual way on the outside.

In making paneling, as in other work, the first and also the most important part is to prepare the wood. Therefore to make the paneling shown in Fig. 1, we shall require (if it is to be made throughout, as shown on the left) two stiles A, three rails, B, C and D (top, middle and bottom) and fourteen muntins. If to bear the right half of Fig. 1, we shall want two additional rails and fourteen additional muntins. The former will be the same as the rails B and C, but the latter will be only half the length of the first; thus the first fourteen may be cut in two and the correct number is at hand. In cutting off the necessary material, each stile should be allowed 2 in. longer than the finished length, and each rail and muntin ½ in. longer. These extra lengths will allow for cleaning off when together, and in the former case will prevent splitting at the ends in wedging up.

In planing up, after each part is faced (that is, planed straight and out of twist and one edge squared accurately), all the inner pieces, to which other parts have to fit to both edges, must be gauged accurately to a certain width. The other edge may be squared at the same time, and then all the parts are ready for setting out. To do this, take the stiles and, laying them together face to face or back to back, mark on them the exact height the finished paneling has to be, as EE, Fig. 2. From this, at the one end, measure inwards the width of the top rail, as F, and from the other end measure the width of the bottom rail, as G. Between these two marks, space out equally for the other three rails, as shown by the marks H. Now from these marks F, G and H set off inwards ½ in., giving the marks I, and these (as regards the three intermediate rails) will give the size of the mortises. At the top end set off from the mark I a distance equal to three-fifths of the width of the top rail, thus getting the mark K, which will be the mortise. At the bottom end divide the space from E to I into four equal spaces as shown, and the mortises will be those marked L. The whole of these marks must be squared over the two stiles, on both edges and across the face, and then by gauging with a double-tooth gauge, or with two single-tooth gauges, the mortises are set out as shown.

The rails and muntins will be set out in a similar manner, always remembering that the mortises must be reduced in width, as shown, to allow for the panel grooves; the tenons must be set out to the full width of the stuff.

In setting out for a quantity of paneling, all the stiles and also all the rails should be done at once.

Fig. 3 gives the stile with the mortises made. Fig. 4 shows the same stile sectionally, this being given so that the method of opening out the mortises at the back or outside edge for the insertion of wedges can be seen and understood.

After the mortising is done, the grooves to take the panels have to be made, and the stile (after this is done) is shown in Fig. 5. Here the groove is shown as being the same width as the mortises, as it should be, but this is sometimes impossible; the rule is that the groove

should come to the face of the mortise, leaving it to come as it will at the back.

In Fig. 6 we have the bottom rail set out and mortised, but the tenon not yet cut. This latter should be sawed in before the panel groove is made, but the shoulders should not be cut until after this is done.

Fig. 7 shows the rail with the groove made, the shoulders cut, and the tenon cut away to fit the double mortises in the stiles. The purpose of reducing the width of the mortises can now be seen, the width of the tenons being reduced by the cutting of the groove as at *M*.

In Fig. 8 we have a portion of the stile *N* with one of the intermediate rails *O* ready for placing in it, the muntins *P* also being ready for fitting into the rail. It will be noticed in this sketch that the panel groove is not so wide as the mortises, being made to suit panels only.

Figs. 9, 10 and 11 show sections of three kinds of panels, the first being parallel in thickness, so that it is faceable on both sides. The second, Fig. 10, is the ordinary mulletted panel beveled off the back to fit the groove. The last, Fig. 11, is beveled at the front, thus giving a rough effect of a raised panel. The method of preparing and fitting all these and others will be given later on when we have explained in detail the methods of setting out.

At the beginning of this article we promised to give the reason why so many workmen failed to make the joints fit in work such as we are now describing. The reason is this: If, in planing up the rails, some are wider than the others, and the setting out is done all alike, as it must be, it follows that if set out to suit the wider rails some of the muntins will come too short, whereas if set out to suit the narrower rails the same pieces will come too long, and difficulties will be met with in putting the work together. Therefore, it is necessary to impress on readers who are interested in this work that the timber must be gauged up truly if the work is to be turned out in a satisfactory manner.—*The Woodworker and Art Craftsman.*

DR. CHAFFEE SPEAKS ON WIRELESS TELEPHONY

On Saturday evening, March 1, Dr. E. L. Chaffee of Harvard University delivered before the New England Wireless Society, Boston, Mass., a very interesting talk on the subject, "The Application of the Chaffee Arc to Wireless Telephony." The Chaffee arc, as is known to persons familiar with wireless telephony, is a comparatively recent invention by Dr. Chaffee. It consists of a pair of electrodes in an atmosphere of hydrogen, the electrodes being of copper and aluminium. It is this particular combination that makes the arc distinctive. The aluminium plays a function here almost identical with the aluminium plate in the electrolytic rectifier. In practice these electrodes are about ½ in. in diameter, and are trued up perfectly square, as the spacing is but three thousandths of an inch between the electrodes. An interesting fact relating to the arc is that it was not originally made for wireless telephony, but for use in a study of cathode rays. Dr. Chaffee said that he could not find an arc that would give him the frequency that he desired, so he set about to make one and finally landed on the type which now bears his name.

The talk was accompanied by a large number of lantern slides which showed many interesting results obtained with this type of arc. One slide showed comparative aluminium and Chaffee arc spectra, and the only visible lines on the arc spectrum were three hydrogen lines, indication that the aluminium does not enter into the arc spectrum, and that it is purely a hydrogen one. Some of the other slides showed various forms of damping, including the straight line, and not the theoretical exponential, damping which results from the ordinary spark radio-telegraphic transmitter. After the talk Dr. Chaffee kindly volunteered to answer any questions on the subject which anyone desired to ask. A large number of the very interested audience availed themselves of this rare chance to get information on wireless telephony from such an authority, and the resulting discussions were very instructive. The next meeting of the Society will be held at Pierce Hall, Harvard University, Cambridge, Mass., on Saturday evening, April 5. Dr. A. E. Kennelly will address the meeting, and there is no charge for admission.

THE GREAT RECENT PROGRESS IN WIRELESS INVENTIONS

Sir Henry Norman, M.P., speaking before the Select Committee of the British House of Commons, which is inquiring into the circumstances of the agreement between the Marconi Company and the British Post Office for the establishment of a chain of wireless telegraph stations throughout the empire, said that the issue was largely a scientific one. The practice of wireless telegraphy had advanced with amazing speed, thanks largely to the work of Mr. Marconi. But during a time to be reckoned almost in months a revolutionary advance would appear to have been made for long-distance wireless. The original spark system, which consisted in flinging out into space by the discharge of a condenser across a gap trains of electromagnetic waves, at their maxiumm at the moment of discharge, and falling off rapidly in amplitude and energy, was employed on most of the Marconi ship and coast stations. For comparatively short distances it gave an excellent service. The researches of Professsor Wien pursued practically by the Telefunken Company produced the "quenched spark" system, or the method of "shock excitation," and it resulted immediately in the transmission of wireless signals to much greater distances with much less energy. The disc discharger invented by Mr. Marconi accomplished the same result, though possibly with less efficiency. The waves thus produced, because they were less damped, approached more nearly to the undamped or continuous waves which had always constituted the ideal of the wireless investigator.

But a more striking discovery was made by Mr. Duddell, which was that by including an electric arc, as seen in the familiar arc lamp, as part of an oscillating circuit, continuous or wholly undamped electric oscillations could be produced; and Mr. Poulsen, a Danish scientist, further discovered that by causing this arc to burn in hydrogen gas the heat of the arc was dissipated so rapidly that a much greater current could be passed through the arc without physical difficulties, and that by causing the arc to pass through a powerful magnetic field the strength and frequency of the oscillations could be increased. The Duddell-Poulsen system, supplemented by the invention of high-speed transmitting and receiving apparatus by Mr. Pedersen, another Danish scientist, marked a great advance in wireless telegraphy, and remarkable long-distance communication at very high speed, with comparatively small powers, had been accomplished. The system was already in use to some extent in both the British and German navies.

There remained, however, the further advance to be made of generating high-frequency continuous waves without the physical disabilities of either spark or arc, and this Dr. Goldschmidt, a German scientist, appeared to have accomplished. He had invented an alternator which transmuted mechanical rotation directly into oscillating current at a frequency of 60,000 cycles per second (or less, corresponding to a wave-length of 16,000 ft. or more, as required by the contract), without the mechanical difficulties of excessively high speed. A demonstration of a small alternator, generating 4 k.w., was given some months ago, and continuous day transmission by this was carried out, he believed, from Berlin to Paris. It was stated that large alternators, generating 150 k.w. had been constructed and had successfully passed the test of being run at full load for many consecutive hours, and that only the completion of the necessary high masts and aerials, which were being rapidly erected, one in Europe and one in the United States, was necessary for a transatlantic test to be made. If the Goldschmidt alternator could put 150 k.w. of a pure continuous wave at 60,000 periods per second into the antenna circuit, as was claimed, a day and night transmission at high speed over 2,000 miles was a certainty.

Moreover, if it would do this, wireless telephony would probably be accomplished. The difficulty of long-distance wireless telephony was to devise a microphone which would not be destroyed by the very heavy main current. In the Goldschmidt system the microphone would only have to carry the exciting current of the alternator, 7 or 8 k.w., instead of the main current. The signals would be untappable, except by a special

receiving apparatus. Further, an advantage of great value for the purposes of these imperial stations, the signals could be changed in a minute from a silent wave only readable on the special receiver to a musical note readable by any ship on the ordinary detector and telephones of every receiving circuit. The purity of the wave rendered the system so selective that a station sending on a wave only differing by 5 per cent. would not interfere. Dr. Goldschmidt claimed that he could receive three different messages on the same aerial at the same time. Dr. Fleming, the scientific adviser to the Marconi Company, alluding in his recent address before the British Association to the inventions of Dr. Goldschmidt, said that telephony across the Atlantic was quite within possibility.

The points urged were: (1) That the future of long-distance wireless communication was almost certainly with a continuous wave system; and (2) that a few months would suffice to decide whether one or other continuous wave system could fulfil the conditions of the imperial wireless service. Sir Henry submitted that it was impossible to come, at this critical moment in the development of wireless telegraphy, to a correct decision without hearing scientific evidence from independent experts. He mentioned the names of Sir Oliver Lodge, remarking that though he received an annual fee from the Marconi company for scientific advice, everyone who was acquainted with him knew that that would not in the least affect his judgment upon any scientific issue, and of Sir Silvanus Thompson. Mr. W. D. Duddell, president of the Institution of Electrical Engineers, discovered the "singing arc," the patent of which was acquired by the Poulsen people, but he understood Mr. Duddell had no connection whatever with the Poulsen syndicate. Dr. Erskine-Murray was a leading consulting expert upon wireless telegraphy, and Captain Campbell-Swinton had not only expert knowledge of wireless but also wide experience of government contracts. Dr. Eccles was another wireless investigator of high qualifications. If the committee heard evidence from some of these gentlemen, it would be in a position to appreciate the scientific situation today as regarded wireless telegraphy.

THE U.S. NAVAL RADIO STATIONS AND THEIR USE IN AID OF SAFE NAVIGATION

In July, 1904, the President approved the conclusions and recommendations of the Inter-Departmental Board which had been appointed by him "to consider the entire question of wireless telegraphy in the service of the National Government." Among these conclusions were the following:

"That wireless telegraphy is of paramount interest to the Government through the Navy Department, and that its use by the Signal Corps of the Army for communication between military posts of the Army and other necessary links will be necessary both in peace and war, and that such use shall be unrestricted.

* * * * * *

"That coastwise wireless telegraphy is not a necessity for the work of the Weather Bureau of the Department of Agriculture, provided that the necessary meteorological data for that Department can be collected by the stations of the Navy Department from ships at sea and by them sent to the Weather Bureau of the Department of Agriculture;

"That the maintenance of a complete coastwise system of wireless telegraphy by the Navy Department is necessary for the efficient and economical management of the fleets of the United States in time of peace and their efficient maneuvering in time of war;

"That the best results can be obtained from stations under the jurisdiction of one Department of the Government only and that representatives of more than one Department should not be quartered at any station."

In accordance with the above, the only U.S. Government radio stations on shore are those under the War and Navy Departments, respectively. Those owned and operated by the Navy Department on shore, including those on lightvessels, are as follows:

LIST OF U.S. NAVAL RADIO STATIONS

Atlantic Coast

The usual wave-length is 600 meters, except for Arlington, which is much longer.

Power	Name of Station	Call Letters
3	Portland, Me.	NAB
2	Portsmouth, N.H.	NAC
5	Boston, Mass.	NAD
3	Cape Cod, Mass.	NAE
2	Nantucket Shoals Lightship	NLA
5	Newport, R.I.	NAF
3	Fire Island, N.Y.	NAG
2	New York, N.Y.	HAH
2	Philadelphia, Pa.	NAI
2	Cape Henlopen, Del.	NAJ
2	Annapolis, Md.	NAK
3	Washington, D.C.	NAL
100	Arlington, Va.	NAA
5	Norfolk, Va.	NAM
2	Diamond Shoal Lightship	NLB
3	Beaufort, N.C.	NAN
2	Frying Pan Shoals Lightship	NLC
3	Charleston, S.C.	NAO
3	St. Augustine, Fla. (wave-length, 300 meters)	NAP
3	Jupiter, Fla. (wave-length, 300 meters)	NAQ
25–2	Key West, Fla.	NAR
5	Pensacola, Fla.	NAS
5	New Orleans, La.	NAT
5	San Juan, P.R.	NAU
5	Guantanamo, Cuba	NAW
25–2	Colon, Isthmian Canal Zone	NAX
1	Porto Bello, R.P.	NAY

Pacific Coast, Etc.

The usual wave-length is 600 meters, with the following exceptions: Point Arguello, 300; St. George, 300.

Power	Name of Station	Call Letters
5	St. Paul, Pribilofs, Alaska	NPQ
1–2	St. George, Pribilofs, Alaska	NPY
10–3	Unalga, Alaska	NPV
5	Dutch Harbor, Alaska	NPR
5	Kodiak, Alaska	NPS
10	Cordova, Alaska	NPA
10	Sitka, Alaska	NPB
5	Bremerton, Wash.	NPC
3	Tatoosh, Wash.	NPD
10	North Head, Wash.	NPE
3	Cape Blanco, Ore.	NPF
5	Eureka, Cal.	NPW
5	Mare Island, Cal.	NPH
3	Farallons, Cal.	NPI
3	Point Arguello, Cal.	NPK
5	San Diego, Cal.	NPL
2	Honolulu, T.H.	NPM
2	Guam	NPN
2	Cavite, P.I.	NPO
5	Olongapo, P.I.	NPT
2	Peking, China	NPP

REPORTS OF DANGERS TO NAVIGATION

Shipmasters in the North Atlantic are invited to communicate reports of dangerous obstructions to navigation to the Hydrographic Office, Washington, D.C., or to the nearest Branch Hydrographic Office, by radio-telegraphy at or near the time of seeing the obstruction. Such messages should be brief and in English. They should be addressed via any naval or commercial radio station along the coast of the United States. The cost of their overland transmission will be borne by the Hydrographic Office. Particular attention is invited to the request that such messages from the ship to the shore should be addressed via a station in the United States.

Shipmasters in the North Pacific are similarly invited to report dangerous obstructions to the nearest Branch Hydrographic Office, by calling a naval radio station, without cost to themselves.

Messages of this kind are sent by the Hydrographic Office or a Branch Hydrographic Office to an appropriate U.S. naval radio station, and are there broadcasted four times daily, viz., at 8 a.m., noon (immediately after the time signal, if sent), 4 p.m. and 8 p.m. Similarly, with storm warnings received by the radio stations from the U.S. Weather Bureau. Ships within range of a naval radio station should be prepared to receive these hydrographic messages and storm warnings at the hours mentioned, and should avoid sending radio messages at these times. One vessel sending may prevent several others receiving information necessary to their safety.

Naval radio stations will furnish this information to passing vessels on request, whenever practicable, at other hours than those mentioned above. Should it not be practicable to send out this information on one of the hours scheduled, it will be held until the next scheduled time, except that important storm warnings, reports of lightships off station, etc., will be treated as urgent and sent out as soon as practicable after each hour scheduled.

In addition to the above treatment of wreck and derelict reports, the Hydrographic Office at once imparts to the Revenue-Cutter Service such reports as fall within the cognizance of that service in its work of assisting mariners in

distress and recovering or removing floating dangers to navigation. Thus, on December 24, 1912, at about 5.30 a.m., the radio station at Brooklyn telephoned to the Officer in Charge of the Branch Hydrographic Office, New York, a radiogram from Captain Lindsay, of the steamer *Turrialba*, that he was ashore off Barnegat, afloat aft, fast forward, heavy snow squalls, wind increasing, assistance necessary.

The Officer in Charge replied by requesting the radio station to inform the Revenue-Cutter *Seneca*, then at anchor in New York Harbor. The *Seneca* immediately got up steam, but was unable to leave the harbor for several hours on account of a heavy snow storm, and she was thus unable to reach the *Turrialba* before 7 o'clock at night, even then having to go out of New York Harbor in the teeth of a gale. The *Seneca* successfully rescued all of the passengers of the *Turrialba* on the morning of the 25th and landed them in New York late that afternoon.

This incident well illustrates the efficiency and usefulness to shipping of the naval radio stations and the Branch Hydrographic Offices.

The Hydrographic Office in Washington was also notified of the wreck in a different manner, having received a radio direct from the *Turrialba* via Cape Henlopen. This radio was immediately telephoned to the Revenue-Cutter Service and also to the Division of Operations of the Navy Department.

Radiograms regarding floating dangers to navigation reaching the Hydrographic office or one of its branch offices, are at once communicated to the Revenue-Cutter Service or to the nearest revenue cutter, and thus assist toward their speedy removal.

PUBLICATION OF WRECK AND DERELICT REPORTS

The latest news relating to obstructions to navigation is also published by the Hydrographic Office in a "Daily Memo-

News of this kind from ships at sea is not considered a commercial message, and no charges are made thereon.

MOST AVAILABLE STATIONS

As a rule, it would be desirable for merchant vessels to communicate habitually with Cape Cod rather than Boston, Fire Island rather than New York, Cape Henlopen rather than Philadelphia, and Point Arguello, Farallons, or Eureka rather than Mare Island, on account of the importance of the official work of the radio stations in the navy yards mentioned. Other radio stations in navy yards and at naval stations are prepared to work directly with shipping.

TIME SIGNALS

Appropriate radio stations send out the noon signal broadcast every day, except Sundays and holidays, for the determination of chronometer errors, and hence time and longitude at sea.

The signals are sent from the Naval Observatory, Washington, for the Atlantic coast between 11.55 a.m. and noon of the 75th meridian west of Greenwich, and from the observatory at the Mare Island Navy Yard between 11.55 a.m. and noon of the 120th meridian west of Greenwich for the Pacific coast.

The wireless sending or relay key in each wireless station is connected to the Western Union lines by a relay at about 11.50 a.m., and the signals are made automatically direct from Washington or Mare Island.

Time signals from each of the observatories mentioned begin at 11.55 a.m., standard time, and continue for five minutes. During this interval every tick of the clock is transmitted, except the 29th second of each minute, the last five seconds of each of the first four minutes, and finally the last 10 seconds of the last minute. The noon signal is a longer contact after this longer break.

All ships should listen in and not at-

attendance. Any vessel provided with a small receiving apparatus with one or two wires hoisted as high as possible and insulated from all metal fittings, or preferably stretched between the mastheads with one wire led down to the receiver, may detect these signals when within range of one of the seacoast wireless stations.

These time signals have been used successfully by vessels for rating their chronometers and have been used by surveying vessels in the accurate determination of longitudes.

Shipmasters are requested to state in their marine data reports to the Hydrographic Office what success they have with this service; and the name or call letters of the station sending the time signal should be given in the report; also position of the ship, and her distance from the station.

This time service involves no charges against the ship receiving it.

The signal . — . . . (WAIT) and the following shall be used to cover cases of interference:

Signal	Question	Answer or Notice
QRM	Are you being interfered with?.....	I am being interfered with.
QRW	Are you busy?....................	I am busy (or: I am busy with....) Please do not interfere.
QRY	When will be my turn?...........	Your turn will be No.....
QRZ	Are my signals weak?.............	Your signals are weak.

PASSING SHIPS SHOULD CALL SHORE STATIONS

Ships passing along the coast should invariably call each naval coast station as they come within range, as important information may be on hand concerning dangers to navigation, storms expected, etc., or private radiograms, in case of stations which handle commercial business. Care should be taken not to interrupt the business of the station, which may be receiving signals at the time which can not be received on board ship on account of the lower aerial; the ship shall, therefore, cease calling promptly on demand.

The position of the ship should be given concisely, immediately after the call is acknowledged and the GO AHEAD signal — . — received from the coast station. The letters TR indicate that the position report follows. After the letters TR send:

(*a*) The approximate distance, in nautical miles, of the vessel from the coast station;

(*b*) The position of the ship given in a concise form and adapted to the circumstances of the individual case;

(*c*) The next port at which the ship will touch;

(*d*) The number of messages, if they are of normal length, or the number of words, if the messages are of exceptional length.

The speed of the ship in nautical miles shall be given specially at the express request of the coast station.

EXAMPLE

After station acknowledges ship's call, ending with —— . ——, the ship sends: TR 50 (nautical miles) off Cape Fear; Habana; 4 (number of messages).

Cleaning Gun Barrels

Lead and powder residue as well as rust can be easily removed from rifle and gun barrels, and if the barrel is not badly pitted, it can be restored to its original brightness and cleanness by using ordinary steel wool in cleaning, says a writer in *Popular Mechanics*. Take a wad of the steel wool just as large as can be conveniently drawn through the barrel and attach it to a stout cord or a small wire and draw it back and forth in the barrel. All rust and residue will be thoroughly removed from the barrel in a few minutes.

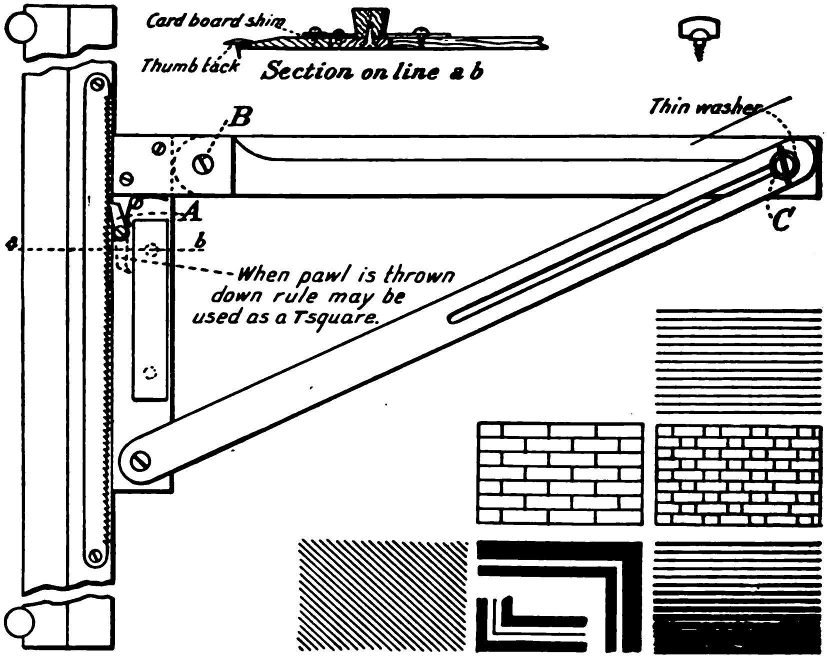
The steel wool will not scratch nor injure the barrel in the least. The No. 0 steel wool is the most desirable to use, and it can be obtained at almost any hardware store.

A PARALLEL RULER AND SECTION LINER

MAURICE COLEMAN

Those who are interested in mechanical drawing will find a section liner a very useful instrument. Following is a description of one that may be made by any amateur at a very small expense, as the pieces of wood required are easily obtained.

beginning ½ in. from one end and making it 6 in. long; slot should be wide enough for one of the ⅜ in. screws to slide easily. Round off end of the 12 in. strip and bevel the edge as shown. File the smaller piece of brass to shape *A*, and drill hole so that ¼ in. screw will have a close fit.



MATERIALS

1 piece wood 18 in. long, 1½ in. wide, 5/16 in. thick;
1 pc. 12 in. long, 1 in. wide, 5/16 in. thick;
1 pc. 6 in. long, 1 in. wide, 5/16 in. thick;
1 pc. 13 in. long, ¾ in. wide, 5/16 in. thick;
1 pc. 3 in. long, ⅝ in. wide, ½ in. thick;
2 round head brass screws, ⅜ in. long;
... head brass screws, ¼ in. long;

Place the larger piece of brass on the 6 in. strip to determine where holes should be drilled for fastening; drill the two holes and also the hole at *B*, making a close fit for ¼ in. screw. Solder a wing into the slot of one of the ⅜ in. screws. Round off the end of the 13 in. strip.

The saw is used as a ratchet and will be found accurately cut at the root of tooth,

build it up slightly by placing a strip of cardboard under the saw, but not wide enough to interfere with the ratchet. Attach 2 in. piece of brass to 6 in. strip, as shown. Attach pawl so it will swing near the brass piece. Fasten spring in place. Adjust pawl to work easily with light pressure of spring. Screw the brass to the rounded end of 12 in. strip, making a swivel joint. Fasten plain end of the 13 in. strip to bottom of 6 in. strip. Place wing screw in slot and screw it into end of 12 in. strip. Attach the 3 in. block by countersinking screws in 6 in. strip. The block is used to hold ruler against 18 in. strip. When the ruler and straight edge form a right angle the ruling will be spaced equal to the cut of the ratchet; to reduce spacing release clamp *C* and drop ruler to desired position. If the left-hand side of straight edge is beveled about one-half its width it may be fastened in any position on drawing-board by using two thumb tacks.

FINISHING BRASSWORK

S. BETTS

Many amateurs in electrical work have, doubtless, admired the very pretty effect of "mottling," seen on shop-made brass instruments. I refer to the sort of veining, something like the veins in marble, running over the surface of the brasswork.

A smooth-finished brass surface readily shows up scratches, and is difficult to lacquer perfectly, evenly, and free from brush marks. On the mottled surface lack of skill is not so noticeable.

The "mottling" is really a series of very fine circles running into one another scratched on the surface of the brass. But the amateur will readily see for himself if he tries the following dodge.

Take a small round piece of wood (a piece of a penholder or pencil will do), put it into a drill chuck or self-centering chuck, leaving an inch or so projecting. Start the lathe, and with a smooth file make the end very slightly convex. From a piece of the very finest emery paper cut a circle about 1 in. or so in diameter. With scissors cut lines radially towards the center, leaving intact in the middle a piece the same diameter as the end of the prepared stick of wood, Fig. 1.

Place the paper against the wood and bring the cut portion over and secure with some stout cotton, Fig. 2.

Now, holding the piece of brasswork in the right hand (it is necessary to have a piece of paper between the brass and the fingers: the grease from the fingers prevents lacquering afterwards), the work being finished to a good surface, run the lathe as fast as possible, press the work lightly against the emery-covered wood, moving it steadily forward at right angles, and a sort of shaded vein will be seen where the rotating emery has cut lightly into the brass. You may follow any pattern you please—say, work diagonally from corner to corner, with other veins crossing at intervals; but the worker will soon be able to obtain some very nice results, and designs will suggest themselves to him.

If two or three diameters of wood are used, the veining may be of different widths. Different grades of emery may also be used, but anything like a coarse grain is useless. Do *not* use emery *cloth*, use only the finest emery *paper*, such as is used for polishing.

The orthodox method is to have sticks of emery composition, with the ends shaped by an old file, as in Fig. 3. This is over-wrapped with paper to strengthen.

A stick of wood may be prepared to this shape, the end then dipped into thin glue, and afterwards fine emery powder, and allowed to dry.

A composition stick may be made by thoroughly incorporating about equal quantities of resin, shellac, and fine emery powder, moistening with methylated spirits, forming it into a thick paste,

Fig. 1

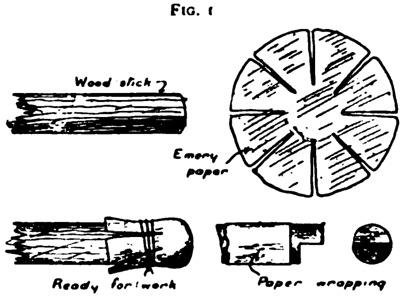


Fig. 2 Fig. 3

and ramming into a mould to dry, and then wrapping round with paper.

A wood mould may be made as follows: Plane one surface each of two small convenient pieces of wood, so that the planed surfaces lie perfectly flat on one another, fix them together by a screw at each corner. On the joint line, as center, drill three holes, so that when the pieces of wood are taken apart half a hole or trough is left on each surface; the planed surfaces are the parting line. Blacklead these holes thoroughly, so as to prevent the composition's sticking, screw together again, and ram in tight as much composition as you can into each hole. When dry, take the wood apart, and out drop the sticks. Shape up the business ends with an old knife and file. The holes may be 1 in. or more in length, and three-sixteenths, one-eighth, and one-sixteenth in diameter, the last size serving for very small jobs.

Commutator bars, levers of switches, etc., look well mottled. Do not lacquer any surfaces where electrical contact is to be made, and do not touch with the fingers. When the piece of brass to be lacquered is put into a clean flame (such as the flame of a spirit lamp) it sweats, and a cloud of moisture appears on the surface; as the metal gets hotter, this passes gradually away, and the moment it has all gone is the time to apply the lacquer (of course, away from the flame). Go over once only as evenly and smoothly as possible. Clean brushes, clean lacquer, and a light, firm hand, and all is well.

If the first attempt is not very good, take off the lacquer with a clean cloth dipped in spirits and try again.—*Model Engineer and Electrician.*

THE EIGHT TALLEST WIRELESS STATIONS IN THE WORLD

Announcement was made last month on behalf of the Marconi Company that contracts had just been let for the construction of eight of the largest wireless stations in the world.

After the erection of one station but one step will remain to jump across the Pacific to Japan. The receiving and sending stations will be 30 miles apart. They will be erected at Honolulu, Oahu, Sandwich Islands; Belinas, Cal.; Belmar, N.J., and along the eastern Massachusetts coast.

Following the erection of the Oahu plant Japan will locate a wireless station, and this will enable the company to throw messages entirely across the Pacific, a distance of 3,394 miles to the nearest land in Japan.

The Marconi Company says that it would have planted its Oriental station in Manila had not the United States Government objected. The Government has a large station there and it was afraid the more powerful Marconi stations might interfere with the receiving and transmitting of marine messages. After Japan the company will erect stations in India and thus communicate with Europe, completing the circle of the globe.

The stations, according to the announcement, will have the highest power and longest range of any in the world. The poles will be the tallest, ranging from 400 to 450 ft. in height. There will be twelve of these poles at each station, arranged in a semicircle, which will cover nearly a square mile. The antennae for these poles will be 80 miles in length and the grounding wires 40 miles, all underground.

The engines of the stations will develop a 1,000 h.p. spark. Because of the power generated the receiving and sending stations will be located on a line 30 miles apart. Closer than that the electric splash, as it is called, would make both stations useless. After 30 miles the etheric waves roll in regular order, which permits other waves to pass them.

The stations must all be attuned to different keys to keep them from interfering with each other and with other stations. Japan has a tuning system all its own and had the first choice of notes for the system, and thereafter the stations were permitted to choose such notes as had not already been preëmpted.

The stations will also be duplexed so they may send out different messages almost simultaneously. Four will go in such rapid succession that it will seem to be simultaneous.

CABLE NOW CLICKS MORSE MESSAGES

Remarkable Invention of Commercial Company's Employe Achieves It

A man sat in a cable office in London the other day and sent a cable message to New York. That doesn't sound remarkable and it isn't. The remarkable part was that the man who received the message at this end of the cable didn't have to read a waving line and translate its ups and downs into the dots and dashes of the Morse code, but instead heard the instrument at his elbow click off the message just as though it had come over a land line from a nearby town.

A message of congratulation went clicking back under the ocean to the man in London, and then there was a lot of handshaking in the offices of the Mackay Companies. The dream of all submarine cable engineers which they had been trying to make come true since the first transatlantic cable was laid in 1858 had at last become a reality, and the long search for a way to operate long-distance cables by sound was ended.

John Gott, chief electrician of the Commercial Cable Company since its organization in 1884, is the man who solved the puzzle. His achievement was announced last month in the annual report of the Mackay Companies to its shareholders made by Clarence H. Mackay, president of the company, on behalf of the trustees. The report says of Mr. Gott's achievement:

"He has invented a device by which the Morse dot and dash signals can be used on long submarine cables, that is to say, messages can be sent by the ordinary land line Morse key and read on a Morse sounder. This invention surpasses anything that has been added to the sub-marine cables since Sir William Thompson (Lord Kelvin) and Cromwell Varley first made the practical operation of long distance submarine cables possible fifty-five years ago.

"It is expected that Mr. Gott's invention will make the cable service as flexible as the land service. It links up cables or land lines, or both, or alternate cables and land lines and is an achievement which inventors and the foremost scientists in the world in cable working have striven to attain since the first Atlantic cable was laid.

"The far-reaching effect of this invention on all kinds of telegraph transmission, both by land and sea, cannot at this time be definitely stated, but the Commercial Cable Company believes that by this invention it will be possible to transmit through automatic repeaters telegraph signals around the world. The Commercial Cable Company has acquired the rights to this invention and has taken out patents all over the world."

By his invention, says the *New York Sun*, John Gott takes his place in the small group of men who have improved submarine cable transmission, and when the next book on submarine telegraphs comes out he will be mentioned with the late Charles Cuttriss, inventor of the vibrator, and the late T. J. Wilmot, who with Cuttriss invented the automatic transmitters. Both of these men, like Mr. Gott, were engineers of the Commercial Cable Company.

While this list of men who have wrestled successfully with the difficulties of cable transmission problems is a short one, the list of failures is very long. The very first transatlantic cable was destroyed by forcing too powerful a current through it in an attempt to work the Morse alphabet of dots and dashes, and the attempts since then to do what Mr. Gott has succeeded in doing have been numberless.

Even the great Edison failed in an attempt to apply the land-wire system to the cables. Some years ago he took what was considered a very promising automatic Morse arrangement to England and in the course of his experiments tried to send the dot and dash code through a cable about 1,000 miles long coiled in a tank. Dot and dash messages are recorded on a tape as well as announced by the click of the sounder.

When Mr. Edison signalled a "dot" at the sending end it came out on the receiving tape in a mark 28 ft. long. Mr. Edison laughed as he contemplated that superdot. He acknowledged that he had not been very successful, and added: "I thought that dot was never going to end."

The explanation of the experts is that

the cables don't discharge their current quickly enough for the system that Mr. Edison tried and so hung on to the dot altogether too long. Mr. Gott found a way to avoid that trick of the cables and the dots and dashes that come over the Commercial Cable Company's lines are as clear-cut as those on short-distance land wires.

But Mr. Gott's invention has just been born, and, although other people were experimenting during all the years since that first attempt burned out the Atlantic cable, they weren't allowed to experiment on the cables themselves, and other systems had to be used. The first of these, invented by Sir William Thomson, was the Thomson reflecting galvanometer, commonly known as the "mirror."

This instrument consisted of a coil of fine wire in the hollow center of which a tube carrying a tiny magnet suspended at right angles by a silk fiber was inserted. On the face of this magnet a small mirror of about ¼ in. diameter was cemented.

A beam of light thrown on this mirror was reflected on a scale placed at some distance from the instrument and the signals, made up of the flashes of light thrown from the mirror to right or left of a zero line, were read on this scale. Since a wire through which a current is passed possesses for the time being properties similar to those of a magnet, the mirror was acted upon by every current passed through the cable line into the coil windings.

It was not an easy job for eyes or nerves to keep track of the flashes of the mirror, but some operators became very expert at it, and in the cable world they still boast of some of the wonderful stunts done by the mirror men. The man who received these literal flashes from the cable read aloud to an assistant his translation of the movements of the beam of light and the assistant wrote the words down on the message forms. They will

in the field of a powerful magnet and the movements of the coil in response to the current sent through the cable are recorded on a narrow paper tape passed in front of a fine glass siphon attached by silk fibers to the suspended coil and dipping into an ink-well.

The business end of the siphon traces in ink a line on the tape, and this line goes up and down in response to the movements of the coil from side to side in response to a change in the polarity of the current. This makes a wavy line something like the graphic charts used to portray statistics of all sorts. When a peak of the line sticks up above a fixed point that means a dot, and a valley is a dash. It takes a keen eye and long training to pick out readily and accurately the slight differences produced when two or more dots or dashes come together, but a permanent record is made, and that was a big step forward in cable message science.

Still, at best the deciphering of the signals of either the old fashioned reflecting galvanometer or the modern siphon recorder was difficult and the signals could only be sent from cable office to cable office. Now with Mr. Gott's invention anyone who can read Morse code as clicked out by the receiver or recorded in printed dots and dashes on the tape will be able to handle cable messages and it looks as though some of the mystery attached to the old time method of cable transmission has departed.

But Mr. Gott's system does a great deal more than increase the accuracy and swiftness of cable message transmission. It hitches up the cables with the land wires so that very soon your cable message filed with the Commercial in an inland town or at San Francisco for transmission to an inland point in England will go right through without human agency except at the transmission and receiving points. With the

GEAR WHEELS AND GEARING SIMPLY EXPLAINED—Part II

ALFRED W. MARSHALL, M.I.MECH.E., A.M.I.E.E.

Gearwheels can be made in the form of a ring with teeth inside the circumference instead of outside. Such wheels are called internal or annular gearwheels. Such a wheel can obviously gear only with another which has external teeth, and is smaller in diameter, because the second wheel is placed inside the first. These wheels are calculated and set out according to the diameters of their pitch circles, as in the case of external toothed gears, the pitch circle of the pinion *P* being inside that of the wheel *W*, Fig. 15, and touching at the pitch point. If the diameter of the pitch circle of the wheel *W* is four times that of the pinion *P*, the latter will make four revolutions for one revolution of the wheel, and so on. The numbering and proportions of teeth apply as in the case of external gears. Cycloidal or involute curves can be used for the shape of the teeth. If cycloidal curves are used, they will be transposed in the case of the teeth of the wheel. The curve-generating circle for the faces of the teeth will roll inside the pitch circle, and therefore produce a hypocycloid, and that producing the flanks will roll outside the pitch circle and therefore produce an epicycloid (see Fig. 16). An internal gearwheel can engage with several pinions simultaneously. In such an instance the curve-generating circle for all the teeth should have a diameter equal to half that of the pitch circle of the smallest pinion. There is an important difference between the working of an internal and external pair of toothed wheels. If the wheels are external, they rotate in opposite directions, but if internal, they rotate in the same direction, as indicated by the arrows, Fig. 15.

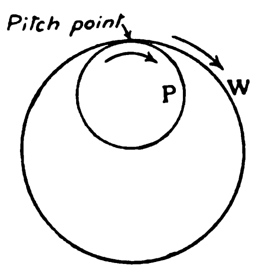


Fig. 15

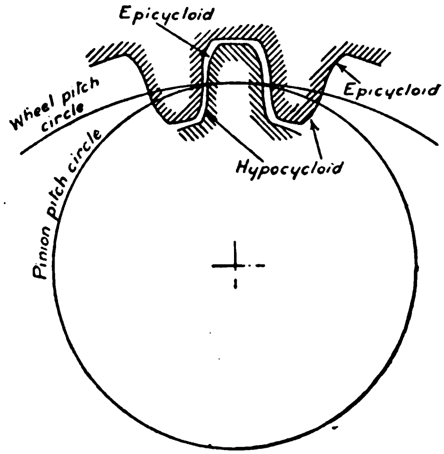


Fig. 16

If the teeth are made as so far explained, with a part projecting beyond the pitch circle as well as a part inside it, any pair will come into contact as they approach the line of centers, and this contact will be maintained to some distance after they have passed the line of centers. For example, a pair of wheels *A B*, Fig. 17, is in gear. The teeth of wheel *A* come into contact with those of *B* to the left of the line of centers *X Y*, the wheels rotating in the direction indicated by the arrows. They are then said to be engaging. After passing the line of centers they are said to be disengaging. The contact is maintained for some distance, but finally ceases as each pair of teeth passes out of gear. The distance through which they make contact when engaging is called the arc or angle of approach, and that through which they move when disengaging is called the arc or angle of recess. The actual path followed by the contact point is a curve in the case of cycloidal teeth, which consists of arcs of the tooth-generating circles *C C*, Fig. 17, any particular tooth commencing to make contact at a point in one circle, and leaving contact at a point in the other circle, as indicated by the full lines. In the case of involute teeth the path of tooth contact is along a straight line, such as *L C*, Fig. 14, commencing inside one pitch circle and ceasing inside the other pitch circle.

The teeth of gear wheels rub together while in motion, causing friction and wear of the surfaces. It is reduced by designing the teeth so that the path of contact is as short as possible. The friction which takes place during engagement in the arc of approach—this would be to the left of *X Y*, Fig. 17—is considered to be more detrimental than that which takes place during engagement in the arc of recess—this would be to the right of *X Y*, Fig. 17. The teeth rub to greater disadvantage when coming into contact than when disengaging. On this account designers of wheel gear in which it is of great importance that friction and wear should be eliminated as much as possible, such as watch and

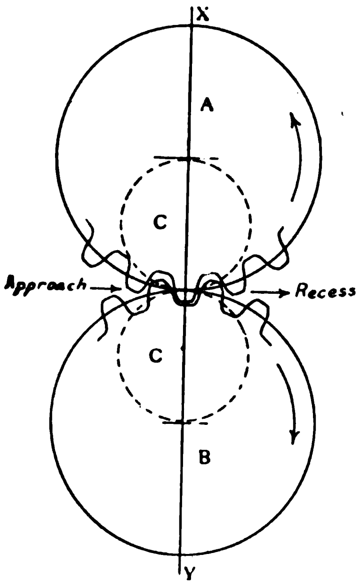


Fig. 17

clock gearing, have favored teeth which only make contact when they have reached the line of centers. Engaging friction is thus reduced to a minimum. This action will be accomplished if the driven-wheel teeth are made without points—that is, they should not have a part which projects beyond the pitch circle. For example, wheels having complete teeth, such as Fig. 17, come into engagement before the line of centers *X Y*. At this stage the flanks of teeth on wheel *B* make contact with the faces of the teeth on wheel *A*, assuming *B* is the driver. After passing the line of centers the faces of teeth on wheel *B*

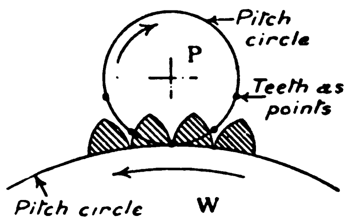


Fig. 18

make contact with the flanks of the teeth on wheel *A*. Therefore, if we desire that contact shall only be made after the line of centers, the points of the teeth on *A* should be removed. It follows from this that the roots of the teeth on *B* will not be required, and as the engagement is only to take place at, or after, the line of centers, *B* must be the driver. If *A* be the driver, the engagement will take place only after the line of centers, which is the condition in this instance to be avoided. The teeth having points are therefore to be put on the driver, and those having no points are to be upon the follower. If cycloidal teeth are used (they should be used), the curve of those upon the driver will be an epicycloid, and that of the teeth upon the driven wheel a hypocycloid. This leads to two distinct forms of teeth for the driven wheel. If the curve-generating circle is made to have a diameter equal to the radius of the pitch circle of the driven wheel, the hypocycloid becomes a straight line (as previously explained), and the teeth have merely straight radial lines for the shape of their flanks. In the second case the curve-generating circle is made to have a diameter equal to that of the pitch circle of the driven wheel; the hypocycloid then becomes a point

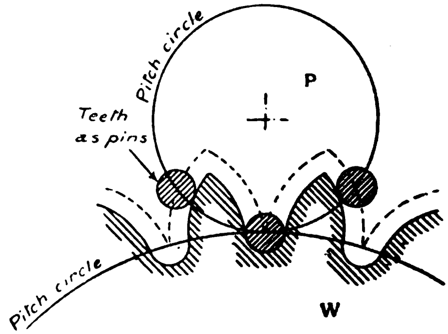


Fig. 19

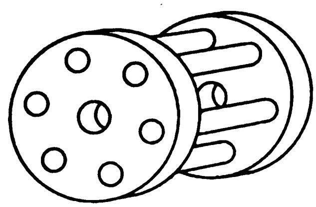


Fig. 20

and the teeth may be pins projecting at a right angle to the side of the wheel. This is the only instance in which the hypocycloid formed by a generating circle of such a proportion to the pitch circle is used for wheel teeth.

When the curve-generating circle is made of a diameter equal to that of the pitch circle in which it rolls, and the hypocycloid becomes a point, some practical modification is necessary, because the teeth are, theoretically, merely points, which, according to Euclid's definition, have no parts nor magnitude. Obviously the teeth must have some thickness, and they become pins as a practical construction. Fig. 18 is a diagram showing the teeth of a pinion *P* as points, being the hypocycloid we have produced by using a curve generating circle having a diameter equal to that of *P*. The teeth on the wheel *W* are entirely outside the pitch circle, and the faces are epicycloids produced by rolling the circle which has generated the point teeth of *P* upon the pitch circle of *W*. To make a practical working construction we fit cylindrical pins to *P* to form teeth. This is quite justifiable, as a circle is the equivalent of a point, and therefore in the particular instance is logically a hypocycloid. The teeth on *W* as originally formed to engage with points are represented by dotted lines, Fig. 19. If we enlarge the points and give them a sensible diameter so that they become pins, it will be necessary to cut away some portion of the teeth of *W*

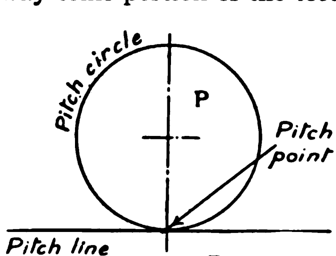


Fig. 21

to provide room for the pins to engage between the teeth; as already explained, we may not alter the distance between the centers of the wheels. Space for the pins is provided by cutting away a portion equal to half the diameter of one of the pins from each face of a tooth along a line parallel to the original curve of the face. This will leave the teeth with the size and shape as indicated by the full lines, Fig. 19, the curves still being epicycloids. To complete the clearance space a semi-circular space is cut away below the pitch line of *W* between each two pairs of teeth. This procedure may be understood by imagining the pin to be a milling cutter moving with its center coinciding with the original lines of the teeth, and thus cutting away the amount of metal necessary to allow the pins to engage. In such a gear, if *W* is the driver,

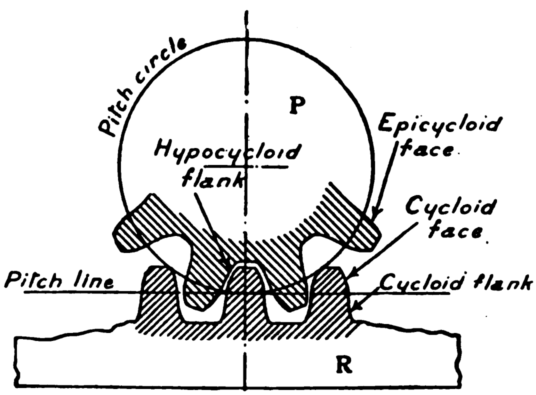


Fig. 22

the engagement of the teeth of the pair of wheels will take place almost entirely after the line of centers. As this is really the object for which the peculiar arrangement is designed, whenever it is used the wheel having the projecting teeth is always made to drive the one which is provided with pins. If the pins are made to drive the teeth, the engagement takes place before the line of centers, and the object of the design is lost. Gears of this kind may also be made in the form of a rack and pinion. The arrangement is much used in clockwork, the wheels with the pins appearing in the familiar form shown by Fig. 20; it is called a lantern pinion. In the main train of wheels of a clock the driving force passes through the gearing from the great wheel

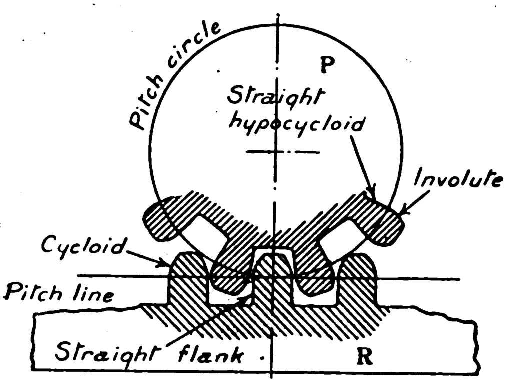


FIG. 23

which is driven by the spring or weight to the escapement. The wheels, therefore, drive the pinions, and the latter can be provided with pins as teeth, hence the extensive use of lantern pinions for clockwork. They have incidentally the advantage of being very strong and durable.

It is possible to design a pinion, also, to engage after the line of centers, with teeth having radial flanks. The number of teeth must be at least ten, and it may be necessary to cut the spaces between the teeth of the pinion with extra width. There would thus be a certain amount of play between the wheels, which would be permissible in clock-gearing where the teeth move slowly, and are kept in contact by a steady, constant pressure. Though the teeth of such pinions need not project beyond the pitch circle, they are usually made with a round end projecting beyond the pitch circle by an amount equal to half the thickness of the tooth, to ensure smooth engagement as the teeth come into action. Clock and watch gearing require large wheels driving very small pinions, and work under special conditions. Anybody contemplating the construction of time-keeping or similar mechanism should consult a treatise on clock and watch gearing. The principles upon which the teeth of the wheels are constructed are, however, precisely those which govern the design of wheel-gearing for machinery in general. Smooth action is very important, therefore the teeth must be of correct design to preserve the relative velocities of the pitch circles. Practical modifications would be introduced to meet the peculiar conditions of clock gearings. For example, the spaces at the roots of the teeth of *W*, Fig. 19, would probably be cut somewhat deeper than indicated, and rectangular instead of semicircular, the sides being radial lines. The teeth of *W* would be of less width than the spaces between the pins on *P*, this amount of play permitting engagement to take place at or very near to the line of centers. The best length for the teeth of *W* would probably be found by experiment.

A rack and pinion gear may be considered as a pair of toothed wheels, one of which, the rack, has a pitch circle of infinite radius—that is, it is a straight line. The teeth can, therefore, be shaped according to the principles already explained. Provided the rack is made of sufficient length, the pinion can be made to give any desired number of revolutions for one stroke of the rack or the rack to move any desired length of stroke for one revolution of the pinion. The gear is to be planned according to the principle used for designing a pair of toothed wheels. The pinion *P* is represented by its pitch circle, and the rack *R* by a pitch line, Fig. 21, which is really the pitch circle of a second wheel stretched out to form a straight line. They touch one another at pitch point x. The pinion may drive the rack, or, conversely, the rack may drive the pinion. As with a pair of wheels, the teeth should be of such a shape that the relative velocities of the pitch circle and line are maintained. The length of stroke which the rack will make for one revolution will depend upon the diameter of the pitch circle of the pinion. When planning a rack and pinion, therefore, the positions of the pitch circle of the pinion and pitch line of the rack should be determined first without regard to the teeth of either. The distance which the rack will move for one revolution of the pinion will be equal to the circumference of the pitch circle of the pinion. Thus, if the diameter of the pitch circle of the pinion be 4 in., the rack will move 12½ in. for each revolution of the pinion. Conversely, if the rack drives the pinion, the latter will be rotated one complete revolution if the rack be moved through a stroke of 12½ in., and so on.

If the rack or pinion are to be indiscriminately driver or follower, the teeth

should be partly formed outside the pitch lines and partly inside, as in the case of a pair of wheels. The curves of the teeth of the pinion will be as follows—the faces epicycloid and the flanks hypocycloid. The curves of the teeth of the rack will be as follows—the faces cycloid, and the flanks cycloid also, because in each instance the curve-generating circle is rolled upon a straight line, Fig. 22; the diameter of this generating circle may be anything not exceeding the radius of the pitch circle of the pinion, and the same generating circle can be used to form the whole of the curves. If a set of wheels is required of different diameters and numbers of teeth, any one to work with the rack, the generating circle should be equal to the radius of the pitch circle of the smallest wheel. The pitch of the teeth is measured on the circumference of the pitch circle of the pinion and along the pitch line of the rack. It may be expressed as diametrical pitch in terms per inch of the pitch circle diameter of the pinion, as previously explained; it will thus also apply as pitch in number of teeth per inch length of the rack. When the curve generating circle has a diameter equal to the radius of the pinion pitch circle the teeth of the pinion will have straight radial lines for the flanks, as previously explained, and the rack teeth will have curved lines for both faces and flanks, the curves being a cycloid. The teeth of the rack may, however, be made to have straight radial flanks. As the radius of a straight line is of infinite length, the flanks of such teeth will be straight lines perpendicular to the pitch line. The faces will be a cycloid formed by the generating circle, which produces the straight radial flanks of the pinion.

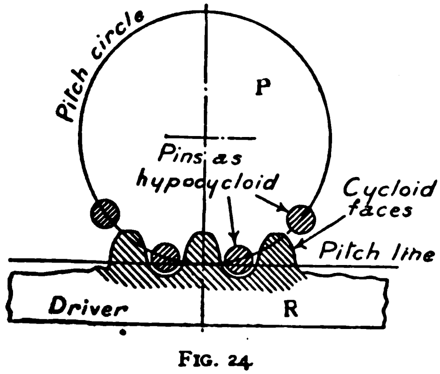


FIG. 24

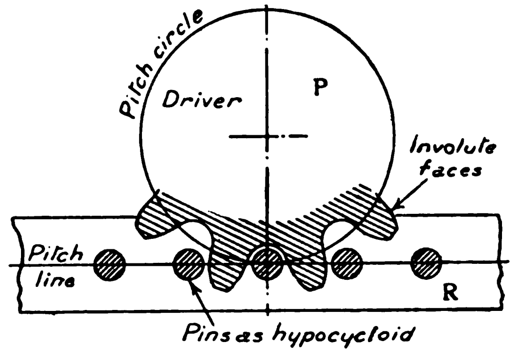


Fig. 25

The faces of the pinion teeth, however, should not be an epicycloid curve, because they should be produced by the generating circle which has produced the so-called radial flanks of the rack. But this circle is one of infinite radius—in fact, it is a straight line. Therefore, the faces of the pinion teeth should be curves produced by rolling a straight line upon the circumference of the pitch circle; the curve should thus be an involute of the pitch circle of the pinion, Fig. 23.

The rack of the pinion may be fitted with teeth in the form of pins on the principle explained with reference to Figs. 18 to 20. As in the case of a wheel and pinion, the pin teeth should be on the follower and not on the driver. If they are placed upon the pinion, the rack should therefore be the driver; if they are placed upon the rack, the pinion should be the driver. The pins represent a hypocycloid produced by a curve generating circle having a diameter equal to that of the pitch circle of the wheel upon which they are placed. Therefore, if they are placed upon the pinion, the teeth of the rack will be formed by a cycloid curve produced by a point on the pitch circle of the pinion when it is rolled upon the pitch line of the rack. The rack teeth will be composed of the part which projects above the pitch line, so that they will have faces only and no flanks, Fig. 24. If the pin teeth are placed upon the rack, they represent, as before, a hypocycloid produced by a curve generating circle having a diameter equal to the pitch circle upon which they are placed. In this case the pitch circle is a straight line, therefore the curves of the teeth of the pinion should be produced by rolling a straight line upon its pitch

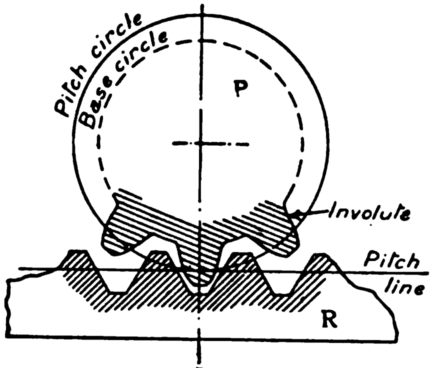


Fig. 26

circle. The curve thus produced will be an involute of that pitch circle. The teeth of the pinion are, therefore, shaped to an involute curve, and consist of the part which projects beyond the pitch circle, no flanks being required, Fig. 25. Gears on this principle should work very smoothly if properly made, as the friction between the teeth takes place almost entirely after they have passed the line of centers. Theoretically, the pin teeth are points, as in Fig. 18; the spur teeth of the driver are cut away to allow for the thickness of the pins, as previously explained with reference to Fig. 19.

The teeth of both rack and pinion may be formed on the involute principle, either to be indiscriminately the driver. In this instance the teeth of the pinion have both faces and flanks formed by one curve, namely—an involute formed by rolling the pitch line of the rack upon a suitable base circle, Fig. 26. The teeth of the rack must also be an involute in theory. But the involute of a circle of infinite radius is a straight line. The teeth will therefore be formed of a straight line for both faces and flanks, and the line should be inclined so that it is a tangent to the curve of the teeth of the pinion. As in the case of a pair of wheels, the pitch circle of the pinion and pitch line of the rack must be in contact, or the relative velocity will not be kept constant except when the teeth are formed upon the involute principle.

(*To be continued*)

PATTERN-MAKING METALS

Metal is used for making patterns in place of wood on account of its greater durability, the fact that it keeps its shape better, and also on account of the fact that more complicated designs can be executed than in wood. Among wooden patterns we find two materials used: pine for the heavier and more common patterns, and mahogany for the more expensive and more delicate patterns, and especially for those which will be in almost constant use.

Turning to metal pattern-making, we find an almost infinite variety of metals used. Where but few metal patterns are used in a shop, and the work is not extremely exact, so that slight variations in the size of pieces do not make much difference, it is common practice to pour the metal patterns from any metal which is being used in the foundry at the time. Castings which are made in this hazardous fashion are usually finished in the same happy-go-lucky way (says H. Malone in the *Pattern-maker*), and the castings made from these patterns certainly show it.

The different metals used for making patterns may be divided into iron and alloys. The alloys may be again subdivided into hard and soft alloys, or into brasses, bronzes and white metals.

Taking up iron first, we find that cast iron is very extensively used for patterns, especially for large moulding machine patterns. It has the advantages of cheapness and ability to keep its shape—that is, it is not only stiff so as to resist bending, but it is hard enough to resist any ordinary bruises. The iron for casting patterns should be what is known as a close-grained gray iron, suitable for the general run of light machinery castings.

Master-patterns are usually made in wood, and the necessary double shrinkage allowances made. If the pattern is to be of exact size, it is also necessary to make the finish allowances in the master-pattern. The pattern casting is then taken to the machine shop and finished either by machining or filing. All pattern-makers know that iron rusts very readily, and this is the greatest objection to the use of iron castings, as they must of necessity be in contact with the damp sand when in use. To protect the surface

of the iron from corrosion, a number of different methods or devices are used. Sometimes the finished surface is rusted, either by dampening with salt water and allowing it to rust, or by dampening with water containing acid or sal-ammoniac. The pattern is then warmed to dry it thoroughly, and the extra rust brushed off with a soft brush. It takes several hours for the rust to penetrate deep enough to make a good surface, and in many cases the castings are left over night. After the surplus rust has been brushed off, the castings are usually given a coating of wax; sometimes this is accomplished by heating the pattern and applying beeswax, after which the surplus is scraped off and the surface rubbed down smooth.

Iron patterns require considerable care in the storage and maintenance, as if they are neglected for even a few days they are liable to rust seriously, and if there are any loose pieces or pins they are liable to rust fast.

As stated, iron patterns are frequently used where relatively large work is to be made. If such patterns were cast solid they would be extremely heavy to handle, and consequently they are generally cast hollow. Here, again, the nature of cast iron lends itself very well indeed to the necessities of the case; on account of the stiffness of the metal very thin patterns can be made, especially when any flat surfaces are supported by suitable ribs.

Cast-iron patterns are not suitable for small, light work for several reasons. One reason is that it is difficult to form delicate and complicated outlines in cast iron, and to prevent these from becoming injured through the corrosion of the metal.

Very frequently, indeed, an order comes into the foundry for quite a large number of castings, for which only one pattern is furnished. Where the pieces are small, the pattern can frequently be used for a master-pattern from which to make a number of other patterns, thus enabling the foundryman to turn out the work much more rapidly. One of the white metals is generally used for producing such patterns as this. An alloy commonly used is made of equal parts of tin and zinc. This alloy will shrink only about 1/64 in. per foot, and hence, especially in the case of small castings, there will be practically no difference between the size of the master-pattern and the other patterns made from it—in fact, in some cases the shaking of the master-pattern enlarges the mould to such an extent that the other patterns are actually larger than the master-pattern, and may require trimming down.

The alloy composed of equal parts of tin and zinc is rather soft, bends fairly easily, and is liable to injury. To overcome these difficulties, some pattern-makers prefer to use an alloy composed of 85 per cent. tin and 15 per cent. antimony. This is quite an expensive alloy, but is surprisingly stiff and hard, and so makes a fairly good metal for a gate of patterns from which only a relatively small number of castings are required. The shrinkage of the tin-antimony alloy mentioned is about 1/16 in. per foot, but in small work the rapping of the master-pattern will more than compensate for this.

In brass foundries the tin-zinc alloys are very largely used for temporary patterns on account of the fact that the old patterns can be melted down and used in making any alloy containing the above-mentioned metals. The tin-antimony alloy is not as good for brass foundries on account of the fact that antimony is not wanted in many standard alloys.

When aluminium first came into use, everyone thought it would make very fine patterns; but its use has not been so extensive as was hoped for. There are several reasons for this, one being that aluminium will not solder as other metals do. For the oxide of aluminium which forms on the surface cannot be dissolved by any of the ordinary fluxes, nor can it be reduced by the aid of any fluxing agent known; so it is practically impossible to get any solder to adhere to aluminium. White metal containing aluminium in any considerable proportions, and, in fact, in relatively small proportions, partakes of the nature of aluminium to such an extent that it cannot be soldered. It will readily be seen that this defect will rule out aluminium and aluminium alloys for use as pattern metals in most cases. Another great disadvantage of aluminium is that it cannot be melted in an iron pot, nor can it be melted and poured as readily as ordinary alloys, and hence it requires

a regular melting furnace, and the services of an experienced melter. The other white metals mentioned can all be melted in iron pots with comparatively little deterioration of the quality of the metal.

A soft white alloy used by many pattern-makers is made by taking standard Babbitt-metal as a base, the metal being made in the following proportions: Babbitt-metal, 1 lb.; tin, 1 lb.; lead, 1 lb. The standard or original Babbitt is composed of tin, 50 lbs.; copper, 2 lbs.; antimony, 4 lbs.; or, in other words, 89.3 per cent. tin, 3.6 per cent. copper, and 7.1 per cent. antimony. Another authority gives the following composition for the original Babbitt: 83.3 per cent. tin; 8.3 per cent. copper, and 8.3 per cent. lead.

It will readily be seen that the effect of using Babbitt in the pattern alloy is to add a small percentage of copper and antimony, both of which have a tendency to harden and stiffen the metal. The large percentage of lead, however, makes the working of the metal easy.

One advantage of the softer white metals is that they are soft enough to be chipped, filed, or scraped with ease, and this greatly reduces the work necessary in making patterns. Not one of the white metals is stiff enough to give good service as gates: the antimony-tin alloy mentioned is sometimes used in cases where the gates are cast on the patterns for a temporary job; but in practically all cases white metal patterns should be provided with gates made from cast or rolled brass. Hand-rolled brass is to be preferred for this, on account of its greater density and consequent stiffness.

There is one advantage in using a white-metal pattern, even where a considerable number of castings are to be made—that is, in the case of experimental work a wooden pattern can be made, a few castings produced from it, and the necessary tests made. If the casting is found suitable for the purpose for which it is intended, a white-metal pattern can then be cast from the wooden pattern, and, owing to the small shrinkage of the white metal, this pattern will serve for making all future castings. If the patterns were to be made from brass or bronze, in many cases it would be necessary to make a wooden pattern, as brass or bronze shrinks more than the desired pattern. It will readily be seen that in such a case as this the use of the white-metal pattern for permanent work saves the cost of one wooden pattern.

For patterns for continual use, as, for instance, on standard work, brass or bronze patterns have become almost universal. They have the following advantages: They are stiffer than white-metal patterns, the gates can be cast with the patterns, and in some cases both gates and runners can be cast together, thus making a very much better and stronger job. The surface of brass resists the scouring action of the moulding sand better than the white metals, and also draws from the mould more freely. A good grade of bronze or gun-metal is very much superior to brass, and hence gun-metal or bronze makes the best patterns. A good standard gun-metal is composed of 32 parts copper, 1 part zinc, and 3 parts tin. A good bronze may be made with the following proportions: 16 parts copper, 1 part tin, 1 part zinc, ½ part lead. The exact composition of either of these alloys, however, is not an absolute essential; a good high-grade gun-metal or bronze will certainly make the best pattern metal available. Common yellow brass, which is composed of 16 parts copper, 8 parts zinc, and ½ part lead, is frequently used as a pattern metal. As already stated, when any of these metals is used, it is necessary first to make a pattern from which the metal pattern is to be cast. If the piece is large or chunky, this pattern may be made of wood; while if it is delicate in design, the master-pattern should be made of brass or bronze, sheet metal being generally employed for this purpose. The highest grade of bronze or gun-metal patterns needs no lacquer to make it draw from the sand freely. High-grade bronze patterns are frequently finished by chasing. This is especially true in the case of art work or leaf designs.—*Model Engineer and Electrician.*

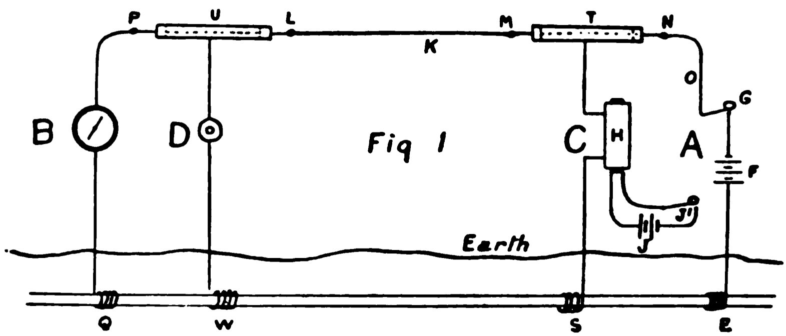
The Russian duma has been asked to appropriate $515,000 for the erection and equipment of wireless stations on the Kara and White Seas. The project is intended to insure telegraphic communication via the Arctic Ocean between the northern and western parts of Siberia and St. Petersburg, Russia.

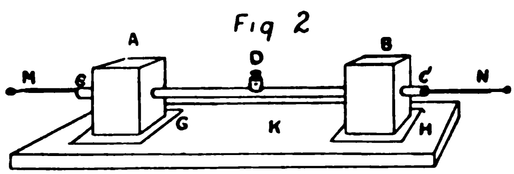
SHOWING THAT TWO CURRENTS CAN BE SENT ALONG ONE WIRE SIMULTANEOUSLY

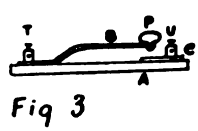
G. G. BLAKE

The following is a description of a simple way of demonstrating the principles of a system invented by Edison for telegraphing to and from trains while in motion by means of currents of high voltage, induced on the outer surfaces of existing telegraph lines which run parallel to the railway, without interfering with any messages already being transmitted along them.

Fig. 1 shows the general arrangement of the apparatus. I will first describe the low-voltage transmitter and receiver.







The transmitter *A* consists simply of a battery of one or two dry cells *F*, one terminal of which is earthed at *E* by connecting it to a gas or water pipe. The other terminal is connected to a Morse key *G*, and then by wire *O* to *N*, where it is fastened to the end of a piece of 1/16 gauge well-insulated electric light cable; the end *M* of this cable is in turn connected to a length of bare 1/16 wire *K*, along which the two currents are to travel. The other end of *K* is connected at *L* to another piece of well-insulated 1/16 cable.

A wire is fastened to this at *P*, which leads to the receiver *B*; this consists simply of a galvanometer, the other terminal of which is earthed at *Q*.

Every time the Morse key *G* is pressed, a current of low voltage will travel along the wire *K* from the battery through the galvanometer, causing its needle to be deflected.

C represents the high-voltage transmitter, which consists of a battery or accumulator, which is connected to the primary of a small induction coil *H* through a Morse key *J*. One of the secondary terminals of this coil is earthed at *S*, while the other is connected to a piece of brass tube *T*, through which the insulated wire *MN* passes.

The receiver *D* is an ordinary telephone, one terminal of which is earthed at *W*, while the other is connected to a piece of brass tube *U*, which encases the insulated wire *PL*.

When the Morse key *J* is pressed, the brass tube *T* is charged with a current of very high voltage, which, by induction, creates a high-voltage current on the wire *NMKLP*, and this wire in its turn sets up a second induced current on the tube *U*, which passes to earth through the telephone *D*, causing its diaphragm to vibrate, and so giving an audible signal.

Now, after having made the necessary connections and tested both the high- and the low-voltage currents separately

to see that they both work properly, it will be found that if the two transmitters are worked simultaneously, both the currents will travel along the wire *K* without in any way affecting each other, and both of the receivers will be affected by their own transmitters only.

The explanation of this experiment probably is that low-voltage currents travel practically along the whole section of the wire, while the high-voltage currents travel only on its surface.

Fig. 2 shows how the brass tubes *U* and *T* are fitted up.

A and *B* are two small blocks of wood 3 x 2 x 2 in., through the center of each of which is bored a hole, through which the brass rod *CC* passes; this is ⅝ in. in diameter and about 20 in. long. On the center of this rod is soldered a terminal *D*.

The insulated wire *MN* (which is of

Fig 4

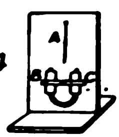
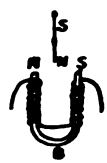



Fig 5.


1/16 gauge) passes through holes in two india-rubber corks which are fitted into each end of the tube.

The two wooden blocks *A* and *B* are glued to two small pieces of thin plate-glass 3 in. square, *G* and *H*, which serve as insulators, and these two pieces of glass are in turn glued to a wooden base-board *K*.

Fig. 3 shows the construction of a simple form of Morse key suitable for this experiment. *A* is a small block of wood, on which is fastened a short piece of steel clock-spring *B* connected to terminal *T*, and a small brass plate *C* connected to terminal *U*. *P* is a small wooden knob, which is fastened to the end of the clock-spring by a round-headed brass screw, the head of which, when the spring is pressed down, touches the brass plate *C*.

Fig. 4 shows a simple way of fitting up a suitable galvanometer for this experiment.

A is a magnetized sewing needle sus-

from an old electric bell would do nicely); *C* is a short piece of wood, through the center of which passes a screw; this holds the magnet in position. Now, if a current be passed through the coils of the magnet (see Fig. 5) the south pole will attract the needle, while the north pole of the magnet will repel it, so that the needle will at once swing to one side or the other, according to which way the current is passing.

Explosive Rock

The danger of explosion in mines is not entirely confined to inflammable gases, carelessly managed fuses, and neglected charges or cartridges. It has been observed that in lead mines some of the slate rocks are likely to burst on being scratched with a pick. The explosion is supposed to be due either to gases inclosed in the rocks, or to molecular strains.

Not long ago a severe explosion of slate rock occurred in a mine at Hillgrove, New South Wales, and the shock was felt for a mile or two over the surrounding country. In this instance, it is believed that the rock wall where the explosion occurred was subjected to a mechanical strain.

Locks, Bolts and Bars

The Egyptian lock, states the *Ironmonger*, was an assemblage of wooden pins or bolts. It is possible that this suggested to Burmah his remarkable invention. The Roman lock was practically a padlock, and it seems probable that the key was of Greek origin. In Latin countries the locksmith never confined himself to mere door furniture.

At the very beginning—as nowadays in France—his art embraced all the wrought ironwork which serves to close and secure our dwellings, from a monumental garden gate and railings to a simple latchkey. The art reached its apogee about the fifteenth or sixteenth century, so far as the former class of work was concerned.

Some mediaeval specimens—the hinges of the doors at Notre Dame, for instance

INDUCTION MOTORS AND HOW THEY WORK.—Part II

NORMAN E. NOBLE

The motor we have considered so far, Fig. 10, is a two-phase two-pole motor, from which we get a rotor speed of nearly 3,000 revolutions per minute; this is rather a high speed, from a mechanical point of view. So we will now consider means for reducing it. We could, of course, supply the motor from a lower frequency, say 25 cycles per second instead of 50; this would reduce the speed to 1,500 revolutions per minute. But this is not always convenient, hence the only alternative is to produce more poles in the revolving field. This can be done by winding more coils on the stator, as in Fig. 12, which represents the necessary slots in stator, to produce a four-pole field, or two slots per pole; we could have more slots per pole, but this example will serve our purpose. The full lines represent one phase, and the dotted lines the other phase; each of the two coils forming one phase is wound so as to produce like poles in that part of the stator they embrace. When the current in the coils AB and CD is a maximum, we should gèt a magnetic field, as shown by the letters NN, these causing consecutive poles SS to appear, as indicated in Fig. 12. When the current in these coils has diminished to zero, the current in the coils EG and FH would be a maximum, and would produce magnetic fields $N_1 N_1$, giving consecutive poles $S_1 S_1$. It is therefore evident that the stator field will move one-eighth of a revolution during a quarter of a period variation of the currents, or one revolution of the field to two periods variation of the currents. Therefore, for 50 periods per second supply, we get a rotor speed of practically 1,500 revolutions per minute. We could by increasing the number of poles still further reduce the field speed; therefore, the rotor speed. For instance, a six-pole field would give 1,000 revolutions per minute, and an eight-pole field 750 revolutions per minute, and so on; this is, of course, reckoning on a supply of 50 periods per second.

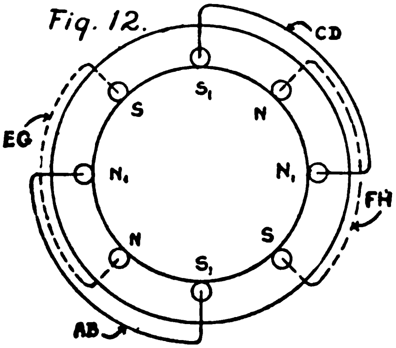


Fig. 12.

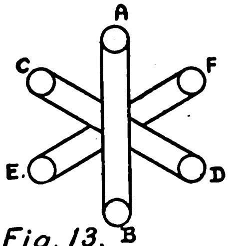


Fig. 13.

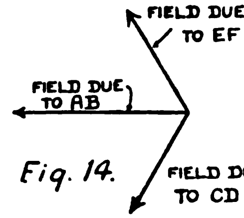


Fig. 14.

As pointed out before, induction motors can be made to run a three-phase supply, that is, each current differing in phase by 120 degrees, Fig. 6. If these currents were passed through the three coils (120 degrees apart), as shown in Fig. 13, each coil being similarly lettered to the phases in Fig. 6 (that is, phase AB passing through the coil $A\ B$), when the coil $A\ B$ produces its maximum magnetic strength, which is horizontal, and its N. pole to be at the left of diagram (being assumed), at this same instant the fields due to the coils CD and EF are not at their maximum strength, but they have equal strengths, as will be seen from the curves, Fig. 6; so we shall get three fields directed as in Fig. 14 (the coils being suitably wound). At the point marked No. 2, Fig. 6, the fields due to the coils CD and AB have reversed their directions, the field due to $C\ D$ being at a maximum, and $A\ B$ at an intermediate value. The field due to the coils $E\ F$ has still the same value and direction as at point No. 1, but it has passed through its maximum value, Fig. 6. From these we get a result, as shown in Fig. 15.

At the point No. 3, Fig. 6, the phase $E\ F$ is a maximum value, and has changed its direction; $C\ D$ has changed its direction, and is not at an intermediate value; and $A\ B$ has the same magnitude and direction as at point No. 2. These cur-

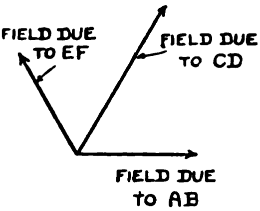


Fig. 15.

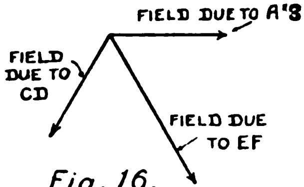


Fig. 16.

rents now produce a field, as indicated in Fig. 16. Finally, at the point marked No. 4, Fig. 6, we get the field, as shown in Fig. 14, which is the same as we commenced with. Thus we have one revolution of the magnetic field for one period of variation of the currents—that is, from point No. 1 to point No. 4, Fig. 6. In each case the three fields give one resultant field, having its direction the same as the strongest of the three, and the magnitude greater than the strongest field, because the other two fields are pulling in the same direction.

This is a two-pole field, and, as with the two-phase field, we get one revolution for one period variation. This three-phase two-pole field consequently suffers from the same disadvantage as the two-pole two-phase field, the speed being too high. To reduce this high speed, we do as we did in the case of the two-phase field—that is, we wind on the stator another set of coils, which produces another field either in front of or behind the original field; therefore, we get a four-pole field, which reduces the field speed to 1,500 revolutions per minute; a further increase in number of the poles reducing the speed still further, as pointed out with the two-phase field.

With regard to the rotor, a squirrel-cage rotor can be employed for either two- or three-phase and single-phase induction motors. In two- and three-phase motors the stator windings is the only place where a difference between the two can be distinguished, generally speaking.

We have yet to deal with the action of single-phase motors, as their action is somewhat different from two- and three-phase motors. A single-phase motor depends for its action on a pulsating field, and not a rotating field, as was the case with the others. Referring to Fig. 7, we found that, with such a winding as shown, we got a pulsating field. Let us assume that we had a two-phase motor in which each phase of the supply had an independent switch; now, while it is running on light load, let us open one of the switches and we shall find that the motor will run at its proper speed, and, what is more peculiar, we can derive mechanical energy, although it is running on one phase. We shall, however, be able to see the current in the phase which is running the motor is greater than when the motor was running on two phases. If we now open the switch of the remaining phase the motor will stop, and if we attempt to try to start the motor again with only one-phase connected, we shall find we are unable to do so; therefore, we conclude that a single-phase motor is not self-starting, but if, when we have opened the switch of the remaining phase to stop it as before, and close it again before the motor comes to rest, we shall find the motor will run up to speed again. This shows that a single-phase motor, if given an initial start as the current is switched on, will run up to its proper speed. Another peculiarity of single-phase motors is, that they will rotate in either direction, just whichever the initial start is given in. The reason for the non-starting of single-phase motors is, because we only have a pulsating field and not a rotating field, consequently no turning effort is given to the rotor, but merely a force first pulling, and then pushing at the rotor. From our mechanical knowledge, we know that a motion of this kind can be converted into circular motion—the treadle motion of a sewing machine affords a good example, Fig. 17.

It is, of course, necessary in the treadle motion that the crank should be past its dead center before the push of the connecting rod is of any use: thus, if we give the wheel a start by hand, it will continue

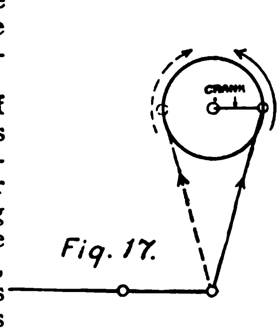


Fig. 17.

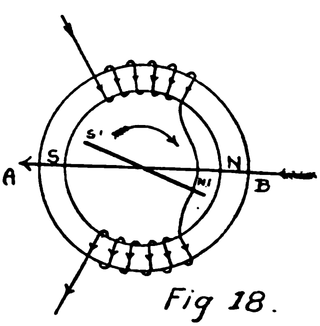


Fig 18.

to rotate in the direction in which it is started. The action of a single-phase motor is much the same: if we give the rotor a start, a revolving magnetic field is formed in the rotor which reacts on the stator pulsating field at that instant, and is reversed as the stator field reverses, the initial start carrying the rotor over what might be termed the dead centers. However, considering the matter electrically, what we have is this: when the current is switched on to the stator windings, a pulsating field is produced which, as it threads through the rotor windings, induces in them a current which itself produces a pulsating field in the rotor. This field, which we will call A, has always the same direction as the stator field, but attains its maximum strength when the stator field has its zero strength, or, in other words, it is 90 degrees out of phase with the stator field. This is so because the strength of any current induced by lines of force cutting a conductor depends on the rate at which the lines of force cut it, or the rate of change of the magnetic field, in this instance. At that instant when the current is at zero, that is, just when it is reversing its direction, the stator field is at its maximum rate of change, hence the induced current will be at its maximum value in the rotor conductors. Therefore, this rotor field A is in the same direction as the stator field, but 90 degrees out of phase with it. As soon as we give the rotor a turn by hand, the conductors cut the lines of force of the stator field; this induces in them a current, and thus produces a magnetic field (pulsating), which is at right angles to the field A. This second field we will call B, and its direction depends on the direction the initial start is given in. This field B is in phase with the stator field—that is, they both attain their maximum value at the same instant. These two rotor fluxes, 90 degrees out of phase with one another, and also at right angles to each other, produce between them a rotating field in the rotor, just as we got a rotating field from two alternating fluxes 90 degrees out of phase, and at right angles to one another, in the two-phase stator. Let the long arrow AB, in Fig. 18, indicate the direction of the stator field at that instant when it is at its maximum value. Now, when we give the rotor an initial start, we get a rotor revolving field as previously stated; let its position and direction at the instant under consideration be as shown by the arrow NS, Fig. 18. The stator field now acts upon this rotor revolving field and produces half a revolution of the rotor. The stator field now changes, owing to the current's changing its direction; that is, it changes its polarity, and we get another half revolution of the rotor.

The motor will now continue these operations and run up to its proper speed; we must not forget at any time, that no revolving field exists in the rotor until we have given it an initial start. As previously mentioned, a single-phase motor will run in either direction, whichever direction the initial start is given in, except in the case where starting devices are used, which will be dealt with later. The motor, as shown in Fig. 18, is a two-pole field motor, and the rotor speed will be almost equal to field speed on light load. The field on a 50-period supply would revolve at 3,000 revolutions per minute in this case. This speed is too high, but can be reduced by increasing the number of poles of the field, just the same as we did with the two- and three-phase motors, the only difference being that single-phase motors have a pulsating field and not a rotating field, as with two- and three-phase motors.

We shall now have to make some provision for making single-phase motors self-starting; in small motors which can easily be started by hand no difficulty will be experienced, but with larger motors it is very troublesome. If we could by any means introduce another current at starting which differed in phase from the main current a quarter of a period, or even less, and pass this extra current through an auxiliary winding on the stator, we should get a rotating field which would start the motor without trouble. This auxiliary starting phase could be connected to the starter in such a manner that it would be cut out on the last notch and the motor would be running as a single-phase machine. This auxiliary phase must be provided from the single-phase mains, the way it is produced being as follows: The auxiliary winding is put on the stator and produces a field nearly perpendicular to the main

field and out of phase with it, the amount of phase difference between the two fields depending on the phase difference of the currents; of course, the winding is in series with a choking coil, and the whole lot in parallel with the main phase and then to the supply, Fig. 19. The choking consists of the usual laminated core, round which a coil of wire is wound, the high self-induction of the choker causes a phase difference between the volts and current in the auxiliary winding. There is, of course, a phase difference between the volts and current in the main phase due to self-induction in same, but is small compared with that in the starting phase caused by the choker; thus, it will be seen that there must exist under these conditions a phase difference between the current in the main phase windings

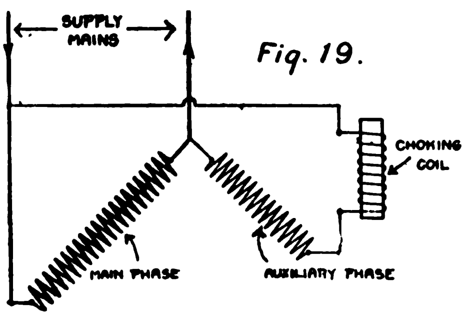


Fig. 19.

and the current in the starting or auxiliary phase windings; but the difference is never a full quarter of a period at any time; so we do not get a true rotating field, but one having rather an elliptical motion. This, however, is quite sufficient to start the motor, and as the lever is moved on to the last stud, the choker and auxiliary windings are cut out of circuit and the main phase runs the motor. We could, of course, get the same result if we substituted a capacity for the choker, but, generally speaking, choking coils are mostly used. There are other methods besides those mentioned, but they all depend on the same idea, and that being a phase difference to be created at starting and cut out when full speed is attained.

Single-phase motors suffer from two disadvantages; that is, they have a low starting torque, whereas two- and three-phase motors have a starting torque capable of dealing with even an overload, single-phase motors only exerting one-half, or even less, than full load torque. For this reason, if the starting load is high, fast-and-loose driving pulleys are provided on the machine or shaft, the belt being put on the fast pulley when full speed has been reached. The other disadvantage is that single-phase motors cannot be overloaded like two- and three-phase motors.

The reversing of alternating-current motors can be effected by interchanging the connections of any one phase in two- and three-phase motors, and by interchanging either the auxiliary phase or the main phase, but not both in a single-phase motor. Single-phase motors, without an auxiliary or starting phase, will rotate in that direction in which the initial start is given.

We have only dealt, so far, with squirrel-cage rotors, which consist of a number of short-circuited conductors, laid in slots, the conductors being permanently short-circuited by means of copper rings, Fig. 11. This type of rotor is only used in small motors, or motors which do not have to start up under load. Let us carefully consider what happens when a motor having a squirrel cage is started up. As soon as the main switch is closed the stator field revolves at full speed, and (leaving the rotor out of consideration for a moment) this revolving field cuts the stator and induces an opposition or back e.m.f., which reduces the supply voltage and allows only the necessary magnetizing current to flow (similar to a transformer with open secondary winding). Now, considering the rotor, the stator revolving field cuts the conductors of same and induces a current; now the rotor is stationary for an instant, and then starts and gathers speed, but it is a short time before it reaches a speed sufficiently high enough to reduce the relative velocity between itself and the rotating field. During this time the revolving field is cutting the rotor conductors at a very high velocity, thus inducing a large current in them, and producing a strong magnetic field in the rotor. This rotor magnetic field weakens the stator field (being in opposition to it) and reduces the back e.m.f. in stator winding, thus allowing a large current to flow from the mains. This is very objectionable from a supply company's

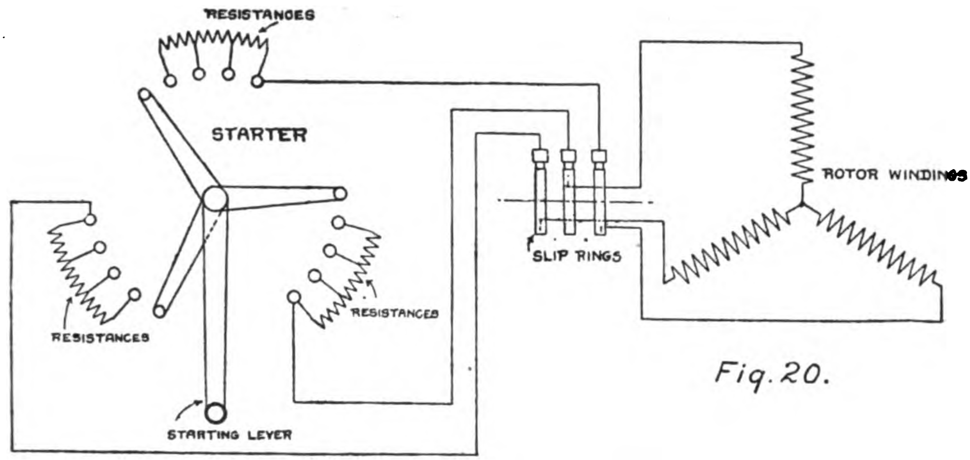


Fig. 20.

point, as it causes a fairly large phase difference between the current and volts, hence a low power factor. If we could put a resistance in series with the rotor conductors, it would help to keep the currents from attaining large values; but this is impossible with squirrel-cage rotors, because of the conductors' being permanently short-circuited. To get over this difficulty a different kind of rotor is employed (constructional), but the principle remains the same. In place of the short-circuited conductors, we use coils wound on the rotor, the ends being connected either in star or in mesh to three slip rings, in the case of a three-phase motor, or four rings in a two-phase (four mains) motor, and two in a single-phase motor; brushes running on the slip rings convey the rotor currents to regulating resistances (a resistance for each phase); Fig. 20 shows a general arrangement of a three-phase starting resistance. When the stator is switched on to the supply, under these conditions only, the necessary magnetizing current flows in the stator windings because the rotor circuits are open (the starting levers being on the dead studs, Fig. 20), and no current can flow to produce an opposition field to the stator field, which would weaken same. The stator field is now revolving at full speed round the stationary rotor. As we pass the starting levers on to the first stud, the rotor circuits are complete, and a current will flow in them, but cannot attain a high value because of the resistances in the circuits; the magnetic field in the rotor is produced, which starts the motor, and as we cut out the resistances the speed increases, and on the last studs it will be seen that the rotor windings are short-circuited, and rotor runs exactly as if it were a squirrel-cage rotor. For the purpose of cutting the starting resistances clear of the motor a special device is mounted on the slip-ring end of rotor shaft, which takes the form of a knob running loose on the shaft, which, when pushed in, connects the slip rings to one another, thus short-circuiting the rotor windings and allowing the starting lever to be put back ready for starting up again without interfering with the motor. In some starting devices the short-circuiting knob, when pushed in, cuts the last resistance steps out, instead of cutting it all out with the starter. Fig. 20 shows the previous method, the short-circuiting knob simply cutting the starter clear of motor. In some cases, where motors are to be put in inaccessible positions, where the short-circuiting knob would be difficult to get at, it is dispensed with, and the starting levers being on the last stud, short-circuits the windings, and they are left in that position as long as the motor is running. Fig. 20 shows this last method. The only objection to this type is that we depend on the brush contact on slip rings for keeping the rotor windings short-circuited; if anything should occur by which one phase of winding became disconnected—for instance, a carbon or brush breaking—we should get an uneven field in the rotor and the speed of motor would drop very considerably. However, it is not very often that it does happen, and with care and periodical

inspection of brush gear very little trouble should occur. In those motors which have the slip short-circuiting device, care must be taken never to start the motor without ascertaining that the short-circuiting knob is pulled out; otherwise, we have a short-circuited rotor, and on closing the main switch a tremendous rush of current would take place; and then, again, the starting resistances would be useless, as they would be cut out, owing to the slip rings' being short-circuited. The introduction of resistance in the rotor circuits at starting has another great advantage, namely, that it causes the motor to exert a large starting torque; the proof of this fact is rather too mathematical to enter into here, so it must be taken for granted. It has been proved that for small values of slip, such as light load, that the torque is proportional to the

$$\frac{\text{slip}}{\text{resistance of rotor circuits,}}$$

and that for large values of slip the torque is proportional to the

$$\frac{\text{resistance of rotor circuits}}{\text{slip}}.$$

From this it is evident that if we increase the resistance of rotor circuit at starting, we can get an increased torque, which is just what is required.

Another method of starting induction motors of the squirrel-cage type, so as to avoid large currents at starting, is by means of what is known as a starting transformer. The starting switch is of the throw-over type; the main current is fed to the starting transformer, and one side of the switch takes a current from the transformer, which has generally about half the voltage of the mains. This gives the motor a chance of getting some speed up before full voltage is switched on. After the motor has gained speed the switch is thrown over to the running side, which cuts the transformer out of

supply, the speed of the stator field will be 1,500 revolutions per minute, and the rotor speed will be somewhat less than field speed. If it were possible for the rotor to attain the same speed as the field, we should get no rotor currents induced, because the conductors would not be cut by the revolving field; therefore, the rotor is bound to run at a less speed than the field. The difference between the two speeds is called the slip. Suppose that in the above case the rotor speed was 1,480 revolutions per minute, then the slip would be 20 revolutions per minute; that is, per cent.

$$\text{slip}=\frac{20 \times 100}{1500}=\frac{4}{3}=1.3 \text{ per cent.}$$

If we increase the load on the motor, the rotor speed will drop slightly, thus increasing the slip, which in turn causes the revolving field to cut the conductors at a quicker rate and produces extra current to deal with the increased load. In first-class motors the slip seldom exceeds 5 per cent. at full load, except in very small motors, where the slip may be as large as 10 per cent. or even more. The currents in the rotor of an induction motor are alternating in character, the frequency of them depending on the amount of slip. Referring to the above case of the two-phase motor, where the slip was 20 revolutions per minute, we should get the same effect if the field was revolving at 20 revolutions per minute and the rotor was stationary; this would give us rotor currents having a periodicity of 40 per *minute*. The periodicity of the rotor currents can easily be calculated, knowing the slip and field speed, from the same formula as we calculated field speeds, *viz.*:

$$\text{Speed of field}=\frac{\text{Periodicity}}{\text{Number of pairs of poles}}$$

from which we get

Periodicity = speed of field x number of pairs of poles.

Putting the values in for the case under

the former equation being used to show the derivation. In making experiments, a tachometer is used to get the rotor speed, the field speed being calculated. There is a disadvantage in using a tachometer for the rotor speed, and that is: only tachometers, as a rule, are capable of reading within about 2 per cent., so that for small values of slip this method is hardly suitable. The method which gives the best results for small values of slip is by inserting an ammeter (preferably one with the zero in the middle) in one phase of the rotor windings, which, as the currents alternate, shows a deflection to the right and then to the left, one complete swing of the needle (*i.e.*, from left to right, and then back again) corresponding to one period variation of the current. This method loses its advantage when the rotor currents alternate quickly, as, with a large value of slip, then the oscillations of the needle become too rapid to be easily counted; then we have to resort to the tachometer method.

In cases where a motor is required to run at two different speeds on the same supply, a special switch is provided in the stator windings, which alters the numbers of pole of the field, thus changing the speed. With regard to speed variation of induction motors, it is safe to say that there are at present no satisfactory means for that purpose, beyond that mentioned. Inserting a resistance in the rotor circuits while under load has an effect upon the speed, but is accompanied by a decrease in efficiency of the motor; and then, again, the variation is very limited.

The efficiency of induction motors (two- and three-phase) at full load is generally about 85 per cent., and decreases with an overload; at light load, the efficiency is low, owing to a low power factor. Single-phase motors on full load do not show quite as high an efficiency, generally speaking.

The advantages of induction motors over all other alternating-current motors are numerous, and in drawing this article to a close, I think they may be enumerated with benefit: (1) Simplicity in construction and working parts, more particularly with squirrel-cage rotors, there being no starting resistances required, hence no slip rings; (2) these motors (excepting single-phase) can deal with very large overloads, and are capable of starting under full load; (3) owing to the fact that the current is led to stationary windings, much higher voltage can be employed, as the insulation is not impaired by having to withstand mechanical strain; (4) they do not require to be run up to speed by external means before being switched on to the supply, as synchronous motors do, but at the same time the speed is not absolutely constant, but varies with the load. With regard to single-phase motors and advantage No. 2, they are not capable of dealing with big overloads and starting up under load as two- and three-phase motors are. This is a point to which much attention has been given by engineers. Many things have been tried to produce a single-phase motor having the advantages of two- and three-phase motors; one of the latest productions on the market being a single-phase motor which can be used for crane-work, where a large starting torque is necessary. This motor is not a true induction at starting, but depends for its large torque on the principle of repulsion motors, which is a large torque at starting, which diminishes as the speed increases (just the opposite to an induction motor); when a certain speed has been attained, the armature (which is similar to a direct-current motor, but having short-circuited brushes placed midway between the maximum and minimum voltage positions) conductors are short-circuited, and the motor then operates as an induction motor. I have, however, had no opportunity for seeing these motors working, and consequently cannot make any statement of their efficiency; it is quite evident that they are not exactly as simple as ordinary induction motors.

There are a number of points which have not been dealt with, for the reason that it would necessitate a considerable amount of mathematics, thus preventing this article from serving its intended purpose, which is a description of induction motors suitable for amateur electrician readers to study without going too deeply into the matter. Nothing has been mentioned about the methods of winding, as this requires to be separately treated.—*The Model Engineer and Electrician.*

A SIMPLE MECHANICAL HARMONOGRAPH

A. H. AVERY, A.I.E.E.

The harmonograph is perhaps one of the most fascinating scientific instruments ever discovered. It deals with the subject of "harmonic" motion, and produces endless examples of most beautifully intricate and symmetrical figures, which are not only intensely pleasing to the eye, but at the same time of great scientific interest and value. The modern view of "energy" in all its various shapes and forms is to regard it as a *vibration*, or harmonic motion, in various complex combinations as regards direction, intensity and rate. Most people are familiar with the experiments of Lissajous, wherein a spot of light was reflected from mirrors attached to the ends of two vibrating tuning forks on to a screen; the result was a symmetrical pattern or figure caused by the spot of doubly-reflected light responding to the vibrations of the forks, and thus rendering, as it were, the sounds actually visible to the eye.

The name "harmonograph" really signifies *sound-writer* in fact, although its scope is by no means limited to acoustical problems. A simple harmonic motion is one recurring at regular intervals, caused by the application of a single disturbing force. Where two or more forces are exerted in regular cycles, the result is compound harmonic motion. Certain time ratios between the two or more applied rhythmic motions always produce the same harmonic figures when in the same relative phase. From what has been said above, it is evident that although it has nearly always been customary to associate harmonographs with the idea of sound waves, they are really instruments which can be used to analyze and imitate any form almost of harmonic wave-motion, whether it be of sound, light, heat, electricity or magnetic and

experience and workshop facilities to construct it. If the following directions are carefully carried out, there will be no difficulty experienced in making a successful apparatus that will produce many thousands of most beautiful figures, with much less labor than required in the making of the more elaborate pendulum-type instruments, as there is no delicate work involved calling for special skill.

Reference to Fig. 2 shows the appearance of the finished instrument, and the relative position of the assembled parts, while Fig. 1 is a scale drawing of the individual items required in building the

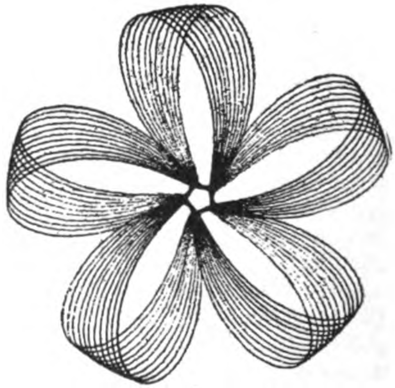


Figure Traced by Mechanical Harmonograph

complete harmonograph. The object to be attained in any form of harmonograph is, of course, to produce two or more harmonic vibrations or movements, and apply the compound impulses to a pen or pencil which is allowed to trace out the resultant motion in the form of a curve or "harmonogram" on a fixed paper. In some instruments the pen is influenced by the combined impulses, while in others the pen vibrates in accord with one impulse only and the paper with the other,

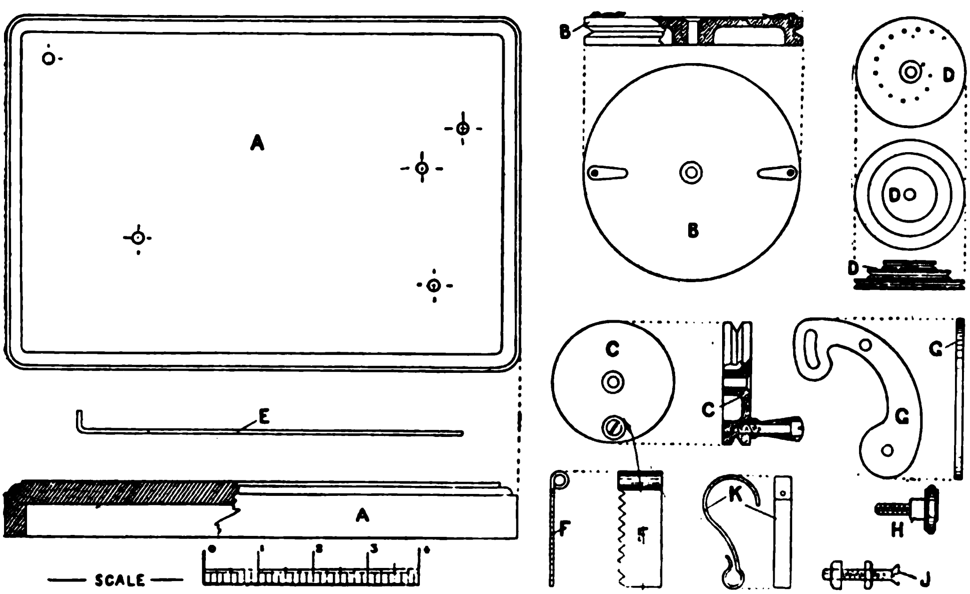


Fig. 1—Details of Complete Harmonograph

revolving pulleys *B*, *C* and *D*, arranged to turn easily on their pivots, one of which *B* forms a table for the paper to rest on, another *D* carrying the arm and penholder, while the third *C* forms the driving pulley, the latter operating the other two by means of an endless driving band.

Different ratios of motion between pen and paper are obtained by the 3-stepped pen pulley *D*. The amplitude, or size of figure, is governed by the throw of the rocker-bar *E*, which can be placed in any one of the fifteen holes shown at different radii in the top surface of pulley *D*, and also by the position of the bar *E* in the notched support *F* at its free end. Also the actual position of the penholder itself affects the contour of the figure as it is slid along the bar *E* to any convenient point.

The baseboard *A* is prepared from walnut or mahogany, nicely polished, and recessed underneath, as shown in section. Mark out five centers for the pivots, as shown in the drawing, and drill 3/16 in. through. Three of these are for the pivots *J*, on which the pulleys turn, the counter-sunk heads being recessed to lie flush with the tops of the pulleys, while the double nut at the other end holds the pivot rigid and vertical, leaving the pulleys free to turn quite easily but without shake. The pulleys themselves are made from hard vulcanized fiber, cut roughly to size, drilled squarely through, and finished up on a mandrel in the lathe.

The table pulley *B* has two little spring brass clips fitted, as shown, to hold the paper down and prevent it from shifting under the pressure of the pen.

The driving pulley *C* is similar to the table pulley, except for the addition of a handle for operating the instrument. The pen pulley *D*, as explained above, has three grooves, and instead of being pivoted direct to the baseboard its pivot is screwed to a swinging brass arm *G*, so that in shifting the driving band from one step to another, the slack in the belt can be taken up, after which the arm is

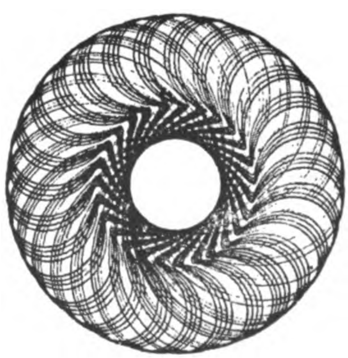


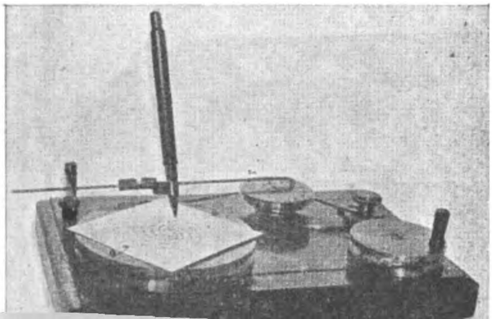
Figure Traced by Mechanical Harmonograph

clamped by the milled head nut *H*. To set out the involute curved line on which the holes are drilled in pulley *D*, coil a piece of thread around a 3/16 in. rod passed through the center of the pulley, having a small loop at the free end. Insert a finely-pointed pencil or scriber in the loop and, keeping the thread taut and the scriber upright, carry the latter round the center rod, when the required curve is traced out. Afterwards the centers for drilling can be set out with dividers and equally spaced. These holes are not to be drilled right through the pulley, but only to a depth of 3/16 in., so that the cranked end of *E* rests at the bottom of the hole.

The penholder bar *E* is made from a length of 1/16 in. silver steel rod, the bent end being inserted in one of the top holes of *D* when in use, while the other end rests lightly by its own weight in any convenient notch on the support *F*. *F* is simply a piece of brass sheet bent round neatly into an eye at one end and screwed firmly to the wood base in a vertical position by a long screw passing through its eye.

The swinging arm *G* is also filed out of a piece of thick sheet brass, one end being slotted to allow sufficient play about the clamp screw *H* from the center hole where it is pivoted to the base, while the other circular-shaped end is drilled and tapped to receive the screw forming the pivot on which *D* rotates. This pivot requires to be a tight fit in *G* and must be flushed off on the underside.

H calls for no particular remark, being merely a milled head clamping screw passing though the slotted end of *G*, and through the base *A* into a stout piece of sheet brass screwed to the underside to form a nut.



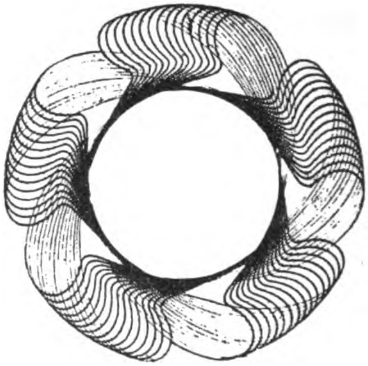


Figure Traced by Mechanical Harmonograph

The penholder *I* is easily formed up out of a piece of spring sheet brass about No. 22 gauge, the small open loop at one end being of suitable size to accommodate the pen, while the other end is turned to a larger radius and bored through at two opposite points in the bend to take the bar *E*. When threaded on to bar *E* with the pen in position, it forms a kind of hinged joint, free to rise and fall if necessary, and so keeping an even pressure on the paper. At the same time, there is sufficient resistance to lateral movement to prevent displacement.

While on the subject of pens, it might be well to mention that by far the most convenient and least troublesome kind for general use is the ordinary fountain pen with a rather fine flexible point, set to rest on the paper at a slight angle. Glass pens give a superior line of more even thickness when set vertically, but are very delicate things to make, and extremely liable to damage, for which reasons they are apt to be out of favor with amateurs. A good style pen works well if fine pointed and with not too heavy a spring. Carefully smoked glass and a needle-point "pen" can be made use of, too, if preferred, good specimens of figures being preserved by taking a photographic print from the tracing used as a negative.

The variety and beauty of the figures obtainable even with this little instrument is very striking; although not impossible, it is difficult to hit off the same figure twice unless the rockingbar *E* is graduated and the holes in *D* numbered for references as well as the notches in *F*.

Crossing the driving band to make the

THE TELEPHONE AS A MEASURING INSTRUMENT

V. W. DELVES-BROUGHTON

The use of a telephone for detecting small currents or small fluctuations of a current is well known to professional electricians; but in the writer's experience few amateurs use this simple device, although it is particularly applicable to their use, as a telephone is always ready at a moment's notice, and no elaborate adjustments are required before a measurement can be taken.

The necessary instruments are a telephone receiver, a microphone transmitter, a few cells, and an induction balance, which I shall first describe.

First obtain a bone knitting-needle, ⅜ in. in diameter if possible, but quite straight and of an even thickness; mine was made out of a ¼ in. needle, as I could not obtain a larger one.

Four bobbins should next be turned out of ebonite, about ½ in. between the flanges and 2 in. in diameter.

These should be made accurately in pairs, and it is most important that the

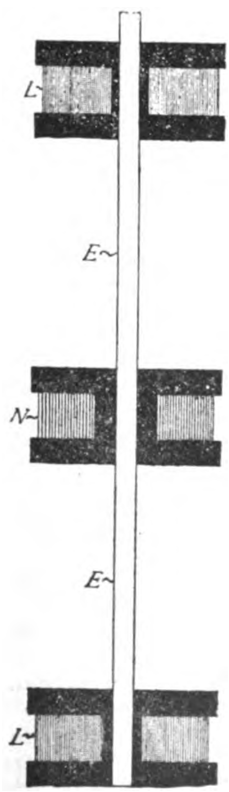


Fig. 1

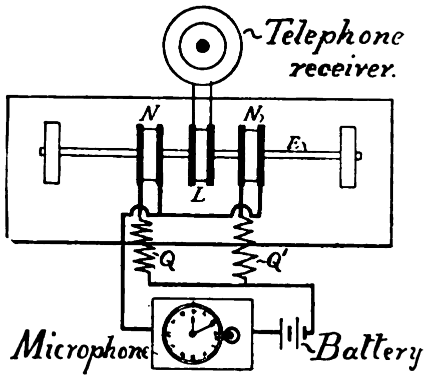


FIG. 2.

diameter of the central stem, the width between the flanges, and the thickness of the latter should be most accurate.

If ebonite cannot be obtained, boxwood may be used, but this should first be rough-turned, and then thoroughly boiled in paraffin wax, subsequently finishing to size.

The holes through the center should be made an accurate fit for the knitting-needle, so that they will slide without rocking.

Two of these coils should be wound with No. 24 d.s.c. copper wire, and the two others with No. 36 s.s.c. copper wire. These pairs of coils must each have exactly the same number of layers on each bobbin and the same number of turns in each layer, so that when wound each pair of coils will have exactly the same resistance and have exactly the same number of turns. The resistance of these coils must now be tested, and if one is found to have a higher resistance than the other, a few layers of the latter must be unwound and rewound with a slightly greater tension on the wire, in such a manner that it may be slightly stretched, which will add to the resistance.

Finally, the ends of the wire are led out by holes drilled in the edge of the flanges and attached to short pieces of twisted twin flexible wire, which, when in use, are fixed to terminals on the base which carries the knitting-needle.

The attachment of the needle to the base should be arranged in such a manner that it can be easily taken out and re-

placed, so that the coils can be arranged in any sequence required.

Three coils only are used at a time, and the most useful arrangement is two of the No. 24 wire coils, with one No. 36 wire coil fixed between them and spaced at equal distances.

Fig. 1 shows the construction of the coils: *L* and *L* being the fine wire coils, *N* one of the coarse wire coils, and *E* the bone needle.

Fig. 2 shows the arrangement for comparing the resistance of two coils of wire Q and Q^1. *N* and *N* are two coarse wire coils connected so as to oppose one another. *L* is the fine wire coil placed exactly between *N* and *N*, so that the alternating current from the microphone in each of the coils *N* and *N* will induce exactly opposing currents in *L*, which consequently will produce no sound in the telephone receiver.

If, however, one of the resistances, Q or Q^1, is greater than the other, the balance will be upset, and a more powerful current will pass through one of the coils *N* than through the other, and to produce silence the central coil *L* will have to be moved nearer to that coil connected in series with the greatest resistance.

It will thus be seen that this instrument will not only detect the difference between two resistances, but will indicate which is the greater.

In Fig. 2 a watch is shown resting on the microphone, and this is an extremely easy manner of producing an unbroken and regular alternating current through the system, but any other appliance, such as a tuning-fork, may be used.

The only objection to this manner of electrical measurement is that it cannot be used for resistances which are non-inductively wound, as the capacity of such coils is quite sufficient to upset the balance between the coils. Two similarly wound coils can, however, be tested for resistance, as the capacity effect of each will neutralize that of the other.

If one of the *N* coils be mounted between two of the L coils, as shown in Fig. 1, the apparatus can be used as a test for hearing; *N* is connected in series with the microphone and battery, and the watch used as before. The telephone receiver is connected in series with the two coils *L* and *L*, which are again connected so as to oppose one another. On shifting *N* slightly out of the neutral position, the ticking of the watch will be heard slightly at first, increasingly strong as the balance is further upset.

If, therefore, a flat be filled on the upper side of *E* and a scale marked upon it, the hearing powers of different people can be tested, or you can test the right and left ears of all and sundry.

This is more a medical than an electrical question, but the same method can be used in making comparisons between different telephone receivers.

Telephone transmitters can be tested in the same manner, and a number of other uses can be found for the apparatus.

The period of an alternating current can be determined by the note produced in a telephone by comparing the note produced in the receiver with a tuning-fork producing a known number of vibrations—a *C* tuning-fork vibrates at 500 per second.—*Model Engineer*.

Cable now Clicks Morse Messages

(*Continued from page* 226)

"human equation" very considerably, and thus "around the world" messages, which the Commercial Company believes it will be able to transmit through automatic repeaters, will be even more accurate than those now passed on from land line to cable and back to land line in making the same journey.

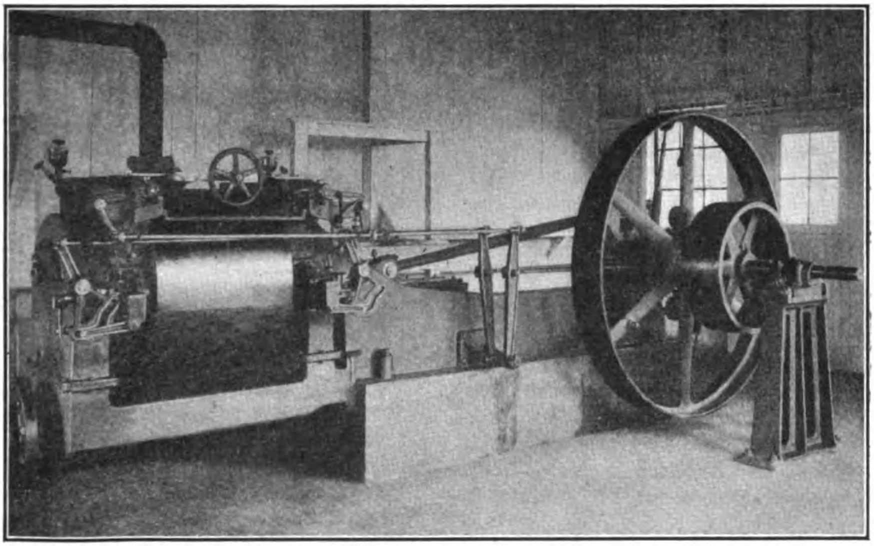
Just how Mr. Gott has overcome the difficulties that stumped the other submarine cable engineers is not being told at present, but it is said that very little new machinery is needed for the operation of this system. The same voltage is used and there is no difference in the actual use of the positive and negative current which operated the siphon recorder instrument. One feature of the Gott system is a delicate instrument which takes the faint note of the far-traveling dot or dash and increases the volume of sound into a full-grown and cheerful sounding "click."

Cable men have never worried much about possible invasion of their field by the wireless, but the Commercial Company says that while the wireless has never been able to compare in rapidity and reliability with cable communication Mr. Gott's invention still further increases the superiority of cable communication over wireless.

A SUN-POWER STEAM ENGINE OPERATING BELOW ATMOSPHERIC PRESSURE

FRANK C. PERKINS

The accompanying illustration shows one of the early installations, devised by Frank Shuman, for the direct utilization of the radiant energy received from the sun, whose experimental solar engine plants have created great interest. The simple engine taking steam at less than atmospheric pressure noted in illustration was tested by Prof. R. C. Carpenter and the data obtained are of the greatest interest. These tests performed on a low-pressure engine of the type used by Mr. Shuman may appear somewhat surprising to many engineers; for it is found that such an engine may be operated with remarkable economy.



Low Pressure Engine Operating with Steam below Atmospheric Pressure, Tacony, Pa., U.S.A.

But little information is available as to the economy of reciprocating engines when operating with less than atmospheric pressure, although numerous tests have been made of nearly all types of engines under the usual conditions of steam of less than atmospheric pressure. Prof. Carpenter states that the reciprocating piston engine with small clearances can be operated with low steam pressures and high vacuum with remarkable economy.

This engine has a cylinder 24 in. in diameter with 24-in. stroke and is double-acting, with admission-valve seats on the barrel of the cylinder near the end and exhaust-valve seats in the heads. It was developed to meet a special demand for a steam motor of small power which would give the highest possible economy with low steam pressure and a high vacuum to furnish power from steam generated by the heat of the sun in plate boilers which presented a large radiating surface. This plant has been installed in Egypt for practical irrigation work.

It is held that the best guaranteed performance for a 25 h.p. steam turbine which could be obtained from any builder

required conditions an engine could be made more economical than the turbine.

It will be seen that the general appearance of the engine is not greatly different from that of others of similar size, except that its working parts are light, and it is provided with a rather long connecting rod. Two eccentrics are used to drive rocker arms, one of which operates the steam valves and the other the exhaust valves. The valves were constructed so as to reduce the clearance space to the lowest possible limit, and the two steam admission valves were of the slide-valve type, arranged to move parallel to the axis of the cylinder on a curved seat concentric with the cylinder.

The steam valve stems were driven by cams lifting against the action of a spring. The eccentric rod rocked the bell crank lever, which motion was communicated by links to the valve, and gave it a sliding motion on its seat. This design afforded steam ports with an opening 20 per cent. of the piston area. These are on the top part of the barrel of the cylinder near each end, and are provided by this construction with extremely short passages into the cylinder, thus making a small clearance loss.

It will be seen that the exhaust valves are unique, as they consist of thin steel plates situated inside the cylinder heads and are moved in a plane perpendicular to the axis of the cylinder. Such valves are extremely unusual in the construction of steam engines and their operation awakens a great deal of interest. The valve is a flat, thin disc provided with slots made to register with corresponding openings in the seat by the action of the valve-moving mechanism.

It is said this valve worked smoothly during the test, and that its continued use apparently even increased the tightness. The fact that the disc is very thin and is held in position by the pressure inside the cylinder doubtless explains why the results were so good. The exhaust valve, it will be noted, is so designed that the area of the exhaust ports when open is very large, amounting to 35 per cent. of the piston area. The exhaust valves are operated by connecting to an eccentric through the medium of rocker-arms, links, and cams.

It will be noted that the steam pipe is shown in the upper left hand corner of the picture, where it joins the steam chest, and the exhaust steam pipe is beneath the cylinders.

This plant was tested at Tacony, Pa., by Profs. R. C. Carpenter and W. M. Sawdon, who point out the facts that because the steam pressure was very low and that the work was done almost exclusively at less than atmospheric pressure, the method of testing which had to be adopted was quite unusual.

Regarding the arrangement of apparatus employed during the test, the engine was arranged to exhaust into a surface condenser connected to a vertical air pump. The water of condensation was delivered by a special hot-well pump into one of two tanks, which were placed on weighing scales and provided with suitable pipe connections and valves so that one could be filling while the other was emptying. The hot-well pump was provided with a governor for maintaining a constant level in the hot well. Observations of the water level were also taken by means of a glass gauge, and a correction applied for differences of level whenever necessary.

As a result of the tests, Prof. Carpenter states that with steam about 1 lb. above atmospheric pressure and with a vacuum of 28 in., the engine required 31.6 lb. of steam per brake horse-power. With the same steam pressure, but with a vacuum of 28.8 in., steam consumption was 28.8 lb. of steam per brake horse-power. These two tests indicate the very material effect of a high vacuum under such conditions of pressure. With a steam pressure of about 8 lb. absolute (6.75 below atmosphere) and 27-in. vacuum, 37.8 lb. of steam were required per brake horse-power per hour. With the same steam pressure but with a vacuum of 28.66 in., 35.7 lb. of steam were required per brake horse-power.

It is pointed out that as compared with the Rankine cycle, the efficiencies vary from 43.8 per cent. to 52.4 per cent., depending on the load and the steam pressures. In Mr. Ackermann's test of the same engine, the relative efficiency as compared with the Rankine cycle under best conditions was 53.8 per cent., which was slightly superior to the results in the above test. There was an independent test of the same engine made by E. P. Haines, and it is said these tests showed substantially the same results.

(*Continued on page* 252)

HOW TO MAKE A COMBINATION LOCK

MARK DAWSON

Some time ago someone asked how to make a lock which would only open when a certain combination of letters had been chosen (the said letters being, of course, attached to the mechanism which works the lock). The lock which I have sketched is on the same principle. This lock can be fitted to any kind of box and, if well-made, is very difficult to open by anyone not knowing where to place the hands of the sham clocks *A* and *B*, Fig. 1. The box which I have is intended to be a snuff box. It is made of sheet brass, being 3 in. long by 1⅝ in. wide by about ½ in. deep. The lid of the box (on the inside of which is fixed the mechanism for working the lock) is fitted between the two pieces *L* and *P*, which, as shown, are part of the box (soldered on). The lid *Q* is hinged to *P* as shown, and *G* is a button by which the sliding piece *E*, Fig. 2, can be slid down or up, as the case may be. The button *G*, which is fixed to the sliding piece *E*, as will be seen from the drawing, cannot slide down when the box is shut, unless the pieces *C* and *D* are so turned as to allow the spigots *H* and *K* to pass into the slots 1 and 2, which allows the lip *N* of the sliding piece *E* to clear the edge of the top of the box *L*. *E* is a piece of 1-16 in. brass sheet, and is kept in position by the sliders *L* and *M*, which are soldered on, and also by the rivet which fastens the button *G* to it. This rivet must be made just a working fit. *C* and *D* are made out of a piece of 1-16 in. brass, the slots 1 and 2 being filed out to exactly fit the spigots *H* and *K*, on the sliding piece *E*. The button *G* is just a piece of ⅛ in. brass, turned up into the shape shown, small

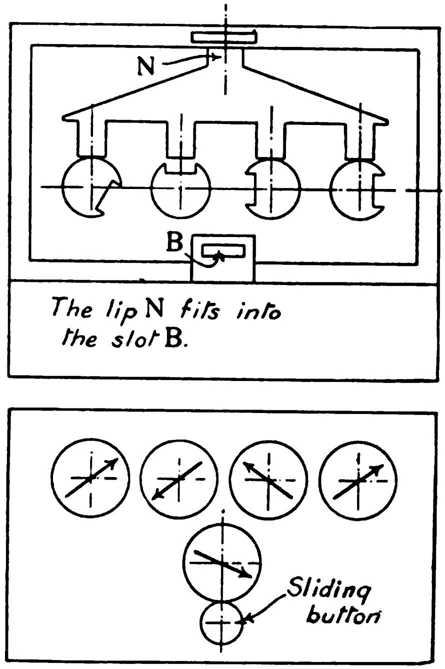


Fig. 3. Arrangement of a Four-Dial Lock

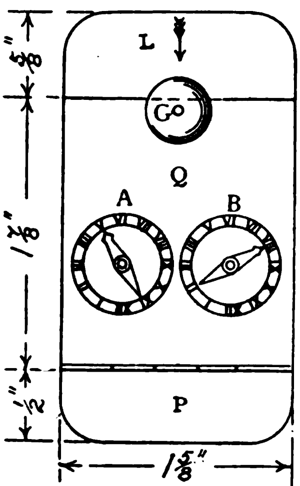


Fig. 1. Exterior of Box

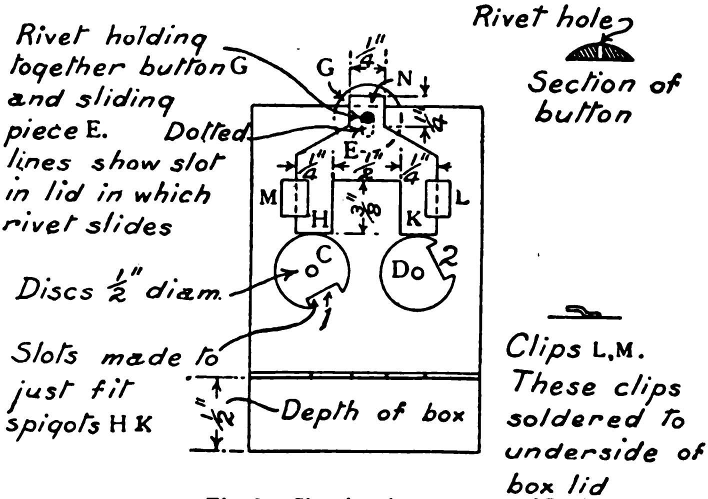


Fig. 2. Showing Arrangement of Lock

grooves being cut round it when turning in the lathe, for fancy appearance.

When the mechanism on the back of the lid is finished, and the position of the hands of the clock which will allow the box to open has been noted, a thin piece of tin can be soldered over the mechanism, to keep it clean. It will be seen that there is only one position of the hands of the clock which will allow the sliding piece *E* to move. This position can, of course, be made anything the maker desires.

A lock which is fitted to a desk is shown in Fig. 3. There are four sham clock faces on this desk. Two for the "minutes" and "hours," and two for the "seconds." The mechanism is the same as before, only there are four spigots instead of two. If one makes the box as it is shown, one might place a dummy sham clock face in the lower position. The clock *A* need not be connected to the mechanism of the lock at all, but would serve to baffle anyone who is trying to open it.

HARDENING FINE CIRCULAR SAWS

B. J. BUCKMAN

Seeing in these pages a short while ago a query on hardening saws, and having occasion to make a very fine circular saw for sawing a slot .015 in. wide, 7/8 in. deep, in the end of some pieces of 3/4 in. round steel, the following method may

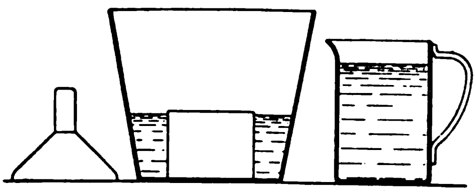


Fig. 1

prove useful to others. I found it an absolute impossibility to harden these saws without buckling in either of the following ways: First, slacking out in water, dipping quickly edgeways; result,

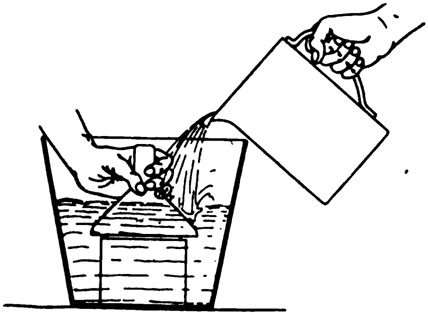


Fig. 2

serious buckle. Second, as above, but dipping indiscriminately; result, much worst buckle of the lot. Fourth, numerous trials on a blank—chisel indentations, dipping in oil, drawing temper from center, and dipping the edge only in a shallow tray of water; but in no case was any success experienced.

Happening to ask a friend of mine—a toolsmith—if he had had any experience with very fine saws, he said: "Yes, I'll do it for you in five minutes, if you will get me the necessary tackle." Needless to say, I soon procured him the tackle, which comprised a bucket, a can, and two pieces of flat-surfaced material larger than the saw. He placed one block in the bucket and filled with water barely to cover, as in Fig. 1. He then heated the saw to a nice red, placed it on the block in the bucket, immediately placing the other flat piece on top, and as quickly as possible covering the whole in water. The result was a dead-flat saw, beautifully hard. I have tried the same method since, and in every case success has been the result.

Sun-Power Steam Engine

(*Continued from page* 250)

It is poined out by Prof. Carpenter that as his tests and Mr. Ackermann's tests fall on the same straight line, it indicates the substantial accuracy of both series of tests. The straight line which characterizes results plotted as explained is frequently referred to as Willan's line,

AN ELECTRIC WIND VANE

C. E. S.

Who does not take an interest in forecasting the weather—and, incidentally, in the direction of the wind? The apparatus to be described was devised on account of the writer's having to spend a great deal of his time out-of-doors, and of his living in a house from which no weathercock was visible.

It consists of a vane, on ball bearings, standing on the top of an iron box, which is attached to a standard of gas tubing. The box contains an eight-part commutator, which is actuated by the spindle of the vane, and from which wires pass, through the standard, to any suitable position in the house, where they are joined to the terminals of an indicator. The latter, on touching a push, shows from which of the eight main points the wind is blowing. The battery consists of three No. 2 Leclanché cells.

Fig. 1 shows the general arrangement of the vane and commutator. The vane, Fig. 2, is made to the dimensions shown,

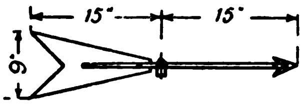


Fig 2

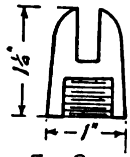


Fig 3


Fig 4

from two pieces of ½ in. x 5/32 in. bar iron, between which the sheet iron point and "feathers" are fastened by two rivets each. Two small strips of sheet lead are held by the rivets at the point, sufficient to make that end rather heavier than the other, when the vane is balanced at its center. If exactly balanced at this stage, it will be found, after two or three coats of paint, that the point will be too light. The balancing is necessary to prevent the vane's having a tendency to cock one end if the standard is not quite perpendicular.

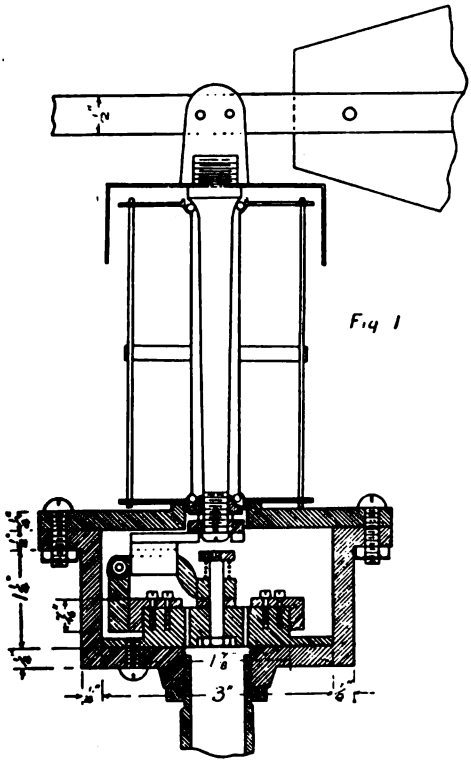


Fig 1

General Arrangement of Electric Wind Vane

The bearings consist of a right-hand rat-trap bicycle pedal, which can be bought second-hand for a few cents. To the end which originally screwed into the crank, and which is uppermost, is fitted a brass cap, which is shown in Fig. 3. This is slotted to admit the stem of the vane, to which it is attached by two rivets. A tinplate raincap, shaped like the lid of a cocoa tin, with a hole in the center, is held between the brass cap and the spindle. Fig. 1 shows it in position.

Examine the spindle of the pedal, and notice whether it projects through the nut which adjusts the bearings. If it does so to the extent of not less than 1/16 in., it will save trouble; if not, the adjusting nut must be turned thinner until it projects that amount. Take out the spindle and file a second flat on the small end, opposite the existing one, extending about ⅛ in. Drill a hole about ⅜ in. deep up the spindle, and tap it ⅛ in. This is shown in Fig. 4.

Three castings will be wanted: one of brass for the commutator, and two of iron for the containing box and its cover. The dimensions of the latter can be seen

in Fig. 1. Notice that there is a boss at the bottom of the box, into which the standard will be screwed; also that there is a thin boss on the top of the cover to be threaded to receive that part of the pedal on which the dust cap was originally screwed. This boss need be only about 1/16 in. thick, its purpose being to allow the pedal to screw home, which without it would be impossible, owing to the sides of the pedal's projecting slightly beyond the end. Have both bosses cast solid.

The cover must be turned on the whole of its lower surface. It is then reversed in the chuck and the boss faced, drilled and threaded to fit the dust cap screw of the pedal. The thread was 36 per inch in the pedal which the writer used. The box must be faced on its upper surface, and rough turned inside. Reverse the chucking for drilling and screwing the boss, which is faced for a nut to bed upon. Screw it 14 per inch to fit ½ in. gas tubing. Fix the cover to the box by six 3/16 in. stove screws and nuts (see Figs. 1 and 5), drilling passing holes through both at once. Mark cover and box clearly so that the correct holes may be brought together again. The joint is made water-tight by a washer of thin asbestos millboard covered on both sides with red lead and oil, and not extending inside beyond the joint face. Give all the parts exposed to the weather two or three coats of paint. The commutator is shown in Figs. 1 and 6, in section and plan. The segments, arm, contact piece, and screws are all of brass, and the whole is mounted on vulcanite. The dimensions of the casting for the segments can be found from the figures, allowance being made for turning all over. After turning to size, if the lathe has a division plate, mark out the division lines, while still in the chuck. Then turn the vulcanite base to fit it nicely. The latter can be made from one piece ½ in. thick, or, more economically, from two pieces ⅜ in. and ⅛ in. thick, joined together by two recessed screws. Fit the sixteen screws holding the segments to the base, which are 5/32 in. in diameter, and are quickly made from 5/16 in. brass wire. Drill brass and vulcanite together, to ensure alignment, and afterwards enlarge those in the brass and tap those in the vulcanite. Do not use wood screws, as these often jam and break in vulcanite. Number brass and vulcanite 1 to 8. Saw the segments apart and clean their edges on a smooth file. No insulating material is needed between them; for the rubbing surfaces being perpendicular, any brass dust formed will fall to the bottom. Notch the inner sides of each segment, opposite the screw, with a rat-tail file, to allow the wires

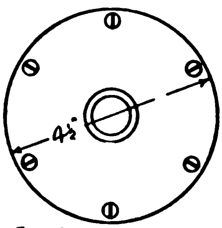


Fig 5

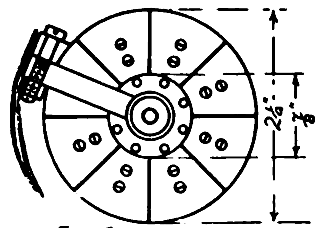


Fig 6

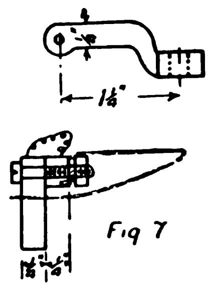


Fig 7

which pass up through the holes shown in the vulcanite to lie snugly against the segments. Otherwise they might foul the arm which carries the contact piece.

This arm is shown in Fig. 7, in side and end elevations. Make it from two pieces of brass. After turning the boss, file the other piece to shape and silver solder the two together. Figs. 1, 6 and 7 show the brass contact piece and the screw holding it in position. Drill a passing hole in the contact piece and a tapping hole in the arm, and fit a lock-nut. The wire spring, which keeps the contact piece up to the segments, is curved as shown to clear the containing box. It is bent into a ring and pinched in position by the lock-nut, and to prevent any chance of its shifting, the fixed end is bent at right angles and enters a small hole in the arm. To ensure good electrical connection between the arm and contact piece, the two are joined by a short length of thin copper wire.

The brass spindle about which the

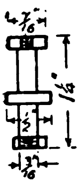
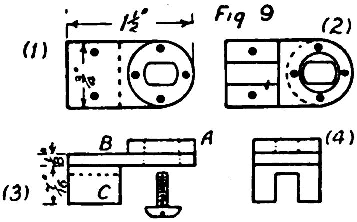


Fig 8

Fig 9



arm turns is shown in Fig. 8. It is fitted with a nut top and bottom—the latter to clamp it to the vulcanite base; and the former to act as a fixed point for a small coiled spring, shown in Fig. 1, which keeps the boss of the arm firmly pressed upon the flange of the spindle. To prevent this spring's cutting into the brass, two thin washers, not shown, are placed for it to bear upon. They can be made from softened clock spring.

The commutator is fixed to the containing box by three 3/16 in. stove screws, one of which is shown in Fig. 1, the vulcanite being tapped to receive them; they must not touch any segments.

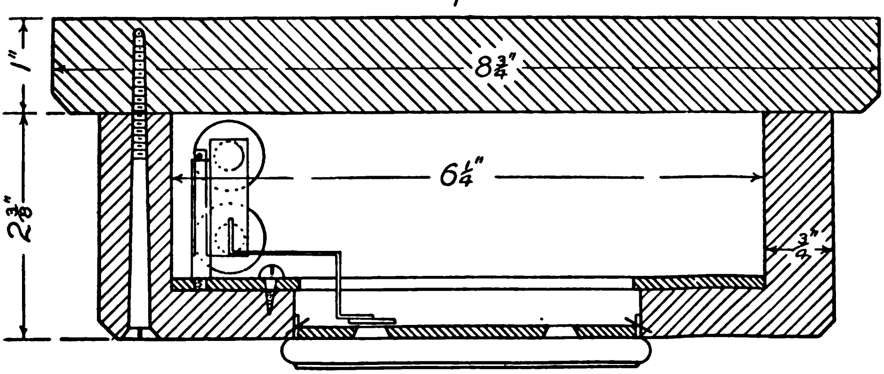
The claw which moves the commutator arm is shown in Fig. 9—(1) plan from above; (2) plan from below; (3) side elevation and (4) end elevation. *B* is vulcanite, to which are riveted the brass pieces *A* and *C*. Copper wire makes excellent rivets, which should be countersunk at each end. The piece *A* is rigidly attached to the lower end of the vane spindle (see Fig. 4), and has an oval hole for it to fit into. A hole is turned in the vulcanite *B* to allow a ⅛ in. screw, with a large thin head, to fix *A* to the spindle, and not project beyond the surface of *B*. The piece *C* has a slot filed to fit easily over the commutator arm. In making the claw the points to notice are, that *A* must be deep enough to allow *B* just to clear the cover of the containing box, and that *C* must engage with the commutator arm without fouling the segment screws. No part of the electric circuit must touch the containing box.

The height of the standard will depend upon circumstances. The writer's is 15 ft. high, to clear some chimney stacks, the upper part being ½ in. iron gas tubing and the lower half ¾ in., joined by a reduction socket. The method of fixing will depend upon whether it is placed outside an attic window or directly on the roof.

A terminal box is placed as close as convenient to where the wires enter the house, so that, if from wear or any other reason, it is necessary to examine the commutator, the aerial portion can be taken down and disconnected without cutting the wires. Having settled the height and position of the standard, find out the length of wire required to pass from the commutator through the standard to the terminal box; allow about 1 ft. extra, and cut off nine lengths. A suitable wire for use throughout from commutator to indicator is No. 22, such as is used in electric bell circuits. One wire is soldered to the bottom of the spindle, Fig. 8, and the other eight pass to the segments, being pinched under the inner screw in each case. The wires being attached, make them into a cable by winding linen tape over them to prevent them being chafed when drawn through the standard.

With an electric bell and battery, iden-

Fig 10



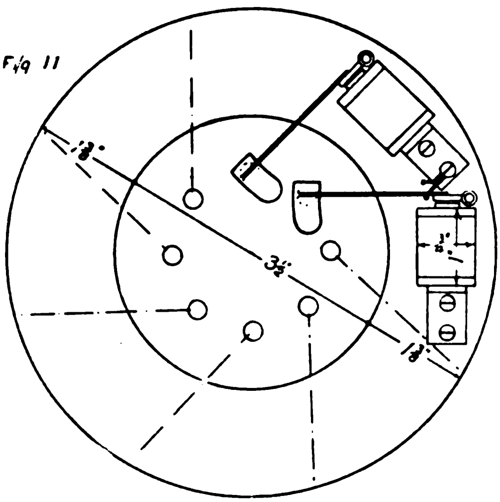
Horizontal Sections Through Indicator

tify the free ends of the wire, and mark them 1 to 8 and *B* (battery) for the common wire.

The indicator is shown in the photograph, and also diagrammatically in horizontal section, in Fig. 10. Fig. 11 shows some of the working parts from behind.

It is similar in construction to an eight-hole electric bell indicator, except that the holes, and hence the mechanism, are arranged in a circle. Each hole has behind it a tinplate flag, painted half white and half black, and when not in use the black is shown. Each flag is soldered to a bent-wire arm, which is itself soldered to a soft iron armature, and

Fig 11



Back View, Showing Mechanism

the whole can turn about a post screwed into vulcanite base. Each arm is placed at an angle of 45 degrees with its hole and is actuated by a two-pole electromagnet.

First make the base from vulcanite ⅛ in. thick. It is 6¼ in. in diameter, with a 3½ in. hole in the center (see Fig. 11). The piece cut from the center can be used to make the lower part of the commutator base, already described. The iron part of the electromagnets is shown in Fig. 12. The yoke, made from ½ in. x 3/32 in. iron, is bent at right angles to form a foot, which is attached to the vulcanite by two ⅛ in. iron screws, the vulcanite being tapped to receive them. The iron for yokes and cores should be annealed.

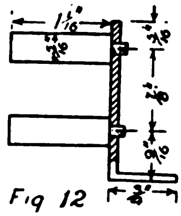


Fig 12

Magnet Cores

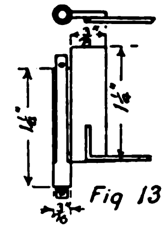


Fig 13

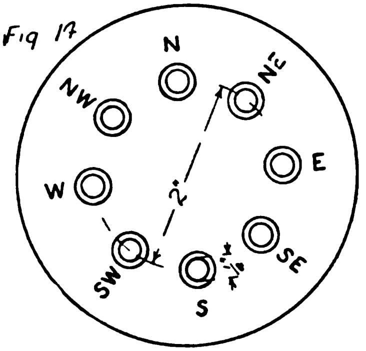
The Armature

The bobbins are shown clearly in Figs. 10 and 11, and they can be made from pear or any close-grained wood. They are wound on a mandrel in the lathe with No. 28 s.c.c. wire, and eight layers can be got on, leaving 3 or 4 in. at each end for connections. Half a pound of wire will be more than sufficient for all the bobbins. After winding, give them a coat of thin shellac varnish.

The armature, shown in Fig. 13, is made of annealed iron about 1/16 in. thick, and has soldered to it a thin brass tube, made out of wire in the lathe. To solder the tube and wire to the armature, cut a slight groove in a piece of wood for the tube to lie in, bring the armature and wire into position, and the two joints can be made in a moment. The wires are bent once at right angles before soldering, the other ends being left for the present.

The post supporting the armature is shown in Fig. 13. It has a shoulder below, and a hole to receive a wire pin above, to keep the armature in place. It is screwed ⅛ in. for attaching to the vulcanite. Number each magnet and armature. Drill and tap the holes in the vulcanite for the magnets, numbering the vulcanite to correspond, and then fix the armature posts.

Fig 14



Brass Dial Plate

Piano Wire Spring

Fig 15

Brass Terminal

Fig 16

From a clockmaker procure the case of an old French clock, the kind referred to being that with a brass cylindrical case about 2 in. deep and about 3⅝ in. in diameter; or of an ordinary alarm clock. The parts wanted are the glass and its retaining ring, which are shown in Fig. 10. Turn a dial-plate of brass about ⅛ in. thick to fit nicely behind the glass, and drill eight ¼-in. holes in it, countersinking them on the side next to the glass, Figs. 10 and 14. Then have the eight points of the compass engraved opposite the holes, and polish the front face and lacquer it.

For the indicator case two pieces of well-seasoned wood are needed. Sycamore is suitable, and looks well if treated with an oak stain and varnished. The front of the case is fastened to the back by three screws, the heads of which should be polished and lacquered. The hole in front will be turned to fit the retaining wing of the glass, and the latter is fixed into the case by two small nails seen in Fig. 10, which also keep the dial-plate in position.

A small push, similar to those used for electric bells, is screwed to the front of the case immediately below the glass. It is shown in the photograph, and needs no description beyond stating that it looks well made of brass and that its base can be made of vulcanite. It cannot exceed 1 in. in diam. as it would then cover one of the screws holding the two parts of the case together; the terminals prevent a screw's being placed at the top.

The vulcanite ring, on which the magnets are mounted, is fastened to the case by three screws, one being shown in Fig. 10. Bend the wire arms of the armatures to shape and solder on the flags, which are painted half white and half black, the latter being the round end. The screws fixing the magnets have each a second duty to perform. Those farthest from their bobbins hold little wire forks which limit the movement of the armature arms. One of these is shown in plan in Fig. 11, the two ends being up at right angles to the plane of the paper. It is made of brass wire, and a little experimenting will show the shape to give it.

The screws next to their bobbins hold springs which act upon the armature arms. They are made of steel piano wire, and one is shown in Fig. 15. It is like a hairpin about 1¼ in. high, with a small ring on one leg, so that it stands nearly vertically to the surface on which it is clamped. If the indicator were without springs, gravity would cause some of the armatures to lie close to their magnets; others would be too heavy for their magnets to attract, and one or two would work satisfactorily. Hence some of the arms will be placed inside the springs and will be pulled by them, and others will be outside and will be pushed. When the indicator is in its proper position each flag should show black, but a slight pull of the armature should make the white appear. In Fig. 11 both are showing white.

Eighteen small brass terminals are needed—nine with nuts and nine without. They are not worth making, as they can be bought for less than the cost of the rod from which to turn them.

Drill a small hole up the screwed stem of nine, Fig. 16, and into each solder about 1 ft. of copper wire. No. 22 cotton-covered is suitable for all connections in the indicator. Connect the two coils of each magnet by twisting together and soldering two beginning or two finishing ends, thus getting N. and S. poles.

To connect the various parts of the indicator, attach two 18-in. lengths of wire to the push, grooving the case inside to allow them to pass under the vulcanite ring and so to the back. Make nine holes through the top of the case, about ½ in. from the base, and spaced ⅜-in. center to center, and screw in the terminals.

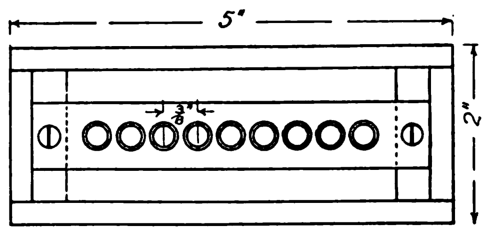
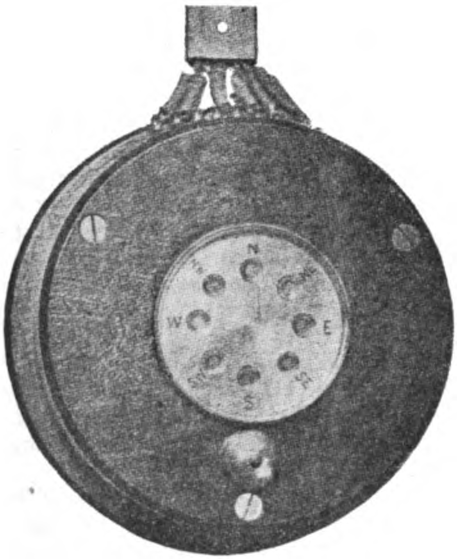


Fig 17

Plan of Terminal Box

Calling the terminal on the left No. 1, connect it with one wire (it is immaterial which) of the magnet which shows N; No. 2 with that showing N.E., and so on to No. 8 with that showing N.W. No. 9 is connected with one of the push wires. Make a ring about 3 in. in diameter of fairly thick uncovered copper wire, and connect with it the second wire of each magnet and the remaining wire from the push. Clean all wires before soldering the joints, and, if killed spirit of salt (zinc chloride) is used, be careful to rub an oily rag over the joint as soon as the solder has set.

Test the indicator with a battery, one wire going to the common terminal, and the other to each of the remaining eight in succession. On touching the push,



Photograph of Wind Vane Electric Indicator

the hole in circuit should show white with a sharp click. Two Leclanché cells should work it well on short-circuit, and if any hole does not act quickly, adjust the

The terminal box is shown in plan, with the lid removed, in Fig. 17. It is square in section and contains a strip of vulcanite into which nine terminals are screwed, the nuts of which serve to connect the wires from the indicator. Nine holes are bored through each side at a suitable level to admit the wires.

It only remains to connect the wires from the commutator in the right order, making the final adjustment by slightly rotating the standard until the points read correctly. This is most easily effected by using a battery and bell at the terminal box, *i.e.*, not making use of the lower part of the circuit. Let the wires from the standard be enclosed in rubber tubing until they enter the house.

A simpler indicator could be made by placing a small electric lamp behind each hole. The writer did not employ this method because the uncertain life of small lamps would probably necessitate fairly frequent renewals, and, further, more current would be used.—*The Model Engineer and Electrician.*

Brick for House Building

One of the greatest advantages of brick for house building is that it can be bought nearly everywhere as a home-made material. Almost every town and village has its brick-yard, by which it is possible to escape the added price of freight. A brick wall is substantial, dry and non-conducting. It can be made attractive in texture by various widths and colors in the joints. Brickwork is dependent on no other material for its trimmings, but is sufficient in itself.

A brick wall never needs paint. If it ever does become shabby, brush it down with a weak solution of muriatic acid, but don't paint it any more than you would paint stonework.

HOW A GRAMOPHONE RECORD IS MADE

A very interesting paper on "The Gramophone and the Mechanical Recording and Reproduction of Musical Sounds," was recently read before the Royal Society of Arts by Mr. Lowell N. Reddie. We give the following extract, describing the method by which the records used on this popular instrument are produced:

I will now deal with the series of operations which go to make up a finished disc record of the Berliner or gramophone type. The person who is making the record sings or plays immediately before the mouth of a horn or funnel, the object of the horn being to concentrate the energy of the sound-waves upon the recording diaphragm. At the narrow end of the horn is the recording sound-box and machine and its attendant expert. The artist is on one side of the screen and the machine on the other, for in all the recording laboratories of talking-machine manufacturers the secrets of the operation of recording are most carefully guarded. The making of a good record is not so simple a matter for the artist as might appear; he often has to make several trials before he learns just how to sing into the trumpet, how near to stand, etc. When singing loud, high notes he must not come too near the mouth of the funnel, as otherwise the vibrations will be too powerful, and the result will be what is technically known as "shattering." When the artist is singing or playing to an accompaniment, another horn connected with the same sound-box is often provided, so that the person of the artist may not obstruct the sound-waves of the orchestra or other accompaniment.

The disposition, too, of the various instruments of an orchestra in the recording-room is of the very highest importance, if the best results are to be

table rotates, it also travels laterally at a fixed and uniform speed, being carried on a revolving threaded spindle, and the wax tablet or blank is thus caused to travel slowly under the stationary recording-box. The sapphire cutting-point of the sound-box is lowered so as to enter the surface of the blank to the depth of about 3½ to 4-1000ths of an inch, and as the machine runs it cuts a fine spiral groove of uniform depth, running from the circumference of the blank to within 2 or 3 in. of the center, according to the length of the selection recorded.

The turn-table travels, as a rule, about 1-100th in. laterally for every revolution, so that the spiral cut comes round about 100 times in the width of 1 in. It will thus be evident that the lateral undulations of the sound-line must be minute in the extreme, as otherwise the lines would at points break into one another.

The recording blank is made of a soapy wax. Each laboratory has its own recipe for the composition of the blank, but, generally speaking, the compound is made up of stearine and paraffin. Many other substances have been suggested, amongst which may be mentioned barium sulphate, zinc white and stearine, ozokerit and paraffin.

The consistency of the blank material must be such that it is stiff enough to retain its shape when the sound-groove is cut in it, and at the same time it must not be so stiff as to offer any great resistance to the cutting-point. It must not chip nor flake, as otherwise the recording point will cut a groove with ragged sides, and this will increase the scratching sound made by the needle on subsequently reproducing. The best results are obtained by a tablet of such consistency that the cutting point detaches an unbroken shaving of wax.

The diameter of the recording blank

½ in. from the edge, it will in one revolution describe a line on the record of a length approximately equal to the circumference of a circle of 11 in. diameter—that is to say, 34.5 in. By the time the recording point has worked in another 3 in. towards the center of the tablet, the length of its path over the wax will approximately equal the circumference of a circle of 5 in. diameter, or 15.7 in. The rate of revolution of the tablet being uniform, the sound-line at the edge of the tablet is accordingly being cut at more than twice the speed that it is cut at nearer the center; and the speed at which the recording point can be made to cut the sound-groove satisfactorily can only be varied within certain limits. If the diameter of the tablet is increased, the outside speed will be too great for proper recording; and if the speed of the turn-table is correspondingly decreased, the ripples in the sound-line near the center will be too close together and cramped; there will be too many vibrations per inch of sound-line to allow of proper recording and reproduction. The obvious solution would be, of course, gradually to increase the speed of the turn-table as the recording point nears the center of the blank, but there then arises the necessity of using mechanism, for securing a corresponding gradual change of speed on the reproducing machine, in order to keep the selection in the proper key. Devices for securing an increased speed have been invented, but they have never come into general use.

The record in wax having been made, the next step is to produce a negative in copper. The wax tablet is dusted with graphite, which is worked into the grooves with a badger-hair brush, to make it electro-conductive, and is lowered into the electrolytic bath of copper salt solution. In order that this negative may be able to resist the pressure to which it is subjected in pressing records, it is necessary that the deposition of the copper should be thoroughly homogeneous. To this end, and also in order to hasten the process so that the blank may not be attacked by the solution, the blank is kept continuously in motion in the electrolytic bath. The process is continued until the copper shell is nearly .9 mm. in thickness. The negative thus formed may be termed the master negative, and from this master a few commercial samples of the record can be pressed by means of which the quality of the record can be tested. It is not, however, usual to press more than two or three records from this negative. Seeing that sometimes as many as 6,000 or more copies are sold of a single record, it is natural that the manufacturers should take steps to enable them to multiply copies without injuring their master negative or having it worn out, for it is not usual at this stage to obtain further negatives from the original wax record. They accordingly make duplicates of their master negative, by taking dubs or impresses of the master in a wax composition, from which in turn working matrices are made. Copper shells are obtained from these dubs in the same way as from the original wax tablet, but the metal is only deposited to the thickness of about ½ mm. The shells are made absolutely true and flat at the back, so that any irregularities caused in the electro-deposition may not be transferred in pressing to the front or face of the shell. They are then backed up or stiffened by a brass plate about 1-10 in. in thickness. The attachment of the backing plate and matrix is effected by sweating or soldering them together under pressure. The backing plate is supported on a heated table, a thin layer of solder is run over it, the shell is laid upon it and pressed firmly down, with an elastic protective cushion of asbestos, for example, placed over the face or recorded surface of the shell to prevent the sound-ridges in it from being injured. The matrix thus obtained is now nickel-plated on the recording side so as to present a better wearing surface, and after polishing is ready for use in the pressing machine.

Attempts have been made to use a recording blank of conductive material, or containing sufficient conductive material to allow of omitting the subsequent graphiting or metallizing of the blank; the objection to this procedure has always been that such substances offered too much resistance to the recording point.

The commercial record is pressed in a substance the essential qualities of which are that it should be hard at normal temperature, but capable of being softened and made plastic by heat. It must be tough and elastic enough not to be easily

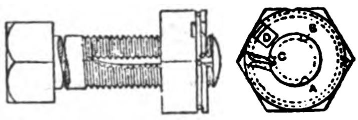
broken when pressed into discs of about 2½ mm. in thickness; it must be thoroughly homogeneous; and it must not be gritty in composition, as otherwise it will augment the scratch of the needle and wear off the point. Finally, the record must be so hard, when cold, that it will retain the contour of the sound-groove, even after it has been played a large number of times. Various substances and compounds have been used or suggested for making records—celluloid, glass, papier-maché, vulcanized rubber, casein, and shellac with an admixture of crocus powder. In nearly all the compounds actually used, shellac is the principal ingredient.

The compound usually employed today is made up of shellac, wood charcoal, heavy spar (barium sulphate), and earthy coloring matter. Various animal and vegetable fibrous materials, such, for instance, as cotton flock, are added to give the record the required toughness. The several ingredients are first finely ground and then carefully measured and mixed according to formula. The mixture is put into a revolving drum, and the flock added. After being passed through a magnetic separator to remove any metallic particles, it is next mixed by heated rollers until a thoroughly homogeneous plastic mass is obtained. The mass is now passed through calender machines, which roll it out into thin sheets, and as it passes from the calender it is divided into sections, each section being about the requisite quantity for one record.

The records are pressed in hydraulic presses. The matrix is heated, and placed face upwards in a mould in the lower half of the press, being centered by a pin passing through the middle of it; the label for designating the selection is placed face downwards on the matrix, and on this is placed, in a warm, plastic state, the quantity of material required for one record. The press is operated, and the mass is immediately distributed all over the mould. Both halves of the press are furnished with cooling plates, through which a stream of water can be passed so that the pressing surfaces can be immediately cooled, and the record mass consequently hardens quickly and retains the impressions of the matrix. The record is removed, and its edges are trimmed up with emery wheels; for the record material is too hard to allow of any cutting instrument's being used. The record is then ready for sale.—*Model Engineer and Electrician.*

A Positive Locknut

The accompanying illustration (taken from the *Horseless Age*) shows a locknut and bolt invented by a Chicago man. The bolt has three grooves, *A*, *B* and *C*, which act as ratchet teeth. The upper part of the nut is so formed that a spring-ring encircles it, the end of the ring being turned inward, as shown at *C*, thus coming in contact with the side of the groove, and effectually preventing the nut from being turned in a left-hand direction. However, right-handed rotation is possible, as the grooves are so shaped that



A POSITIVE LOCKNUT.

the end of the spring-ring slides up the inclined surface easily. In order to release the nut, a slot *D* is provided, which allows the point of a nail, or any similar object, to be placed under the spring-ring, and thus raise the point out of the groove, when the nut can be taken off. This arrangement allows an adjustment at any time of one-third of a rotation.

British Government Refuses to Release Wireless Company

The English Government, acting on the advice of the Parliamentary select committee appointed to investigate the matter, has refused to release the Marconi Wireless Company from its agreement to establish a wireless chain of imperial stations. The Marconi company pleaded the expense as a reason for the annulment of the contract.

The contract for the establishment of wireless communication between the British dominions throughout the world was in part due to the combination of the Atlantic cable companies under American control. The Marconi company was to receive $300,000 for each station, exclusive of the site and building, and also 10 per cent. of the gross receipts for a term of 28 years from the date of the conclusion of the first six stations.

QUESTIONS AND ANSWERS

Questions on electrical and mechanical subjects of general interest will be answered, as far as possible, in this department, free of charge. The writer must give his name and address, and the answer will be published under his initials and town; but, if he so requests, anything which may identify him will be withheld. Questions must be written only on one side of the sheet, on a sheet of paper separate from all other contents of the letter, and only three questions may be sent at one time. No attention will be given to questions which do not follow these rules.

Owing to the large number of questions received, it is rarely that a reply can be given in the first issue after receipt. Questions for which a speedy reply is desired will be answered by mail if fifty cents is enclosed. This amount is not to be considered as payment for reply, but is simply to cover clerical expenses, postage and cost of letter writing. As the time required to get a question satisfactorily answered varies, we cannot guarantee to answer within a definite time.

If a question entails an inordinate amount of research or calculation, a special charge of one dollar or more will be made, depending on the amount of labor required. Readers will, in every case, be notified if such a charge must be made, and the work will not be done unless desired and paid for.

1960. **Transformer Load.** J. W. G., Arlington, Md., says: Would you kindly advise me the safe load in amperes that could be taken at the lowest voltage, also at the highest voltage, when using the auto-transformer described in a recent issue of *Electrician and Mechanic*. Ans.—The entire winding is of No. 10 wire, which has a cross-section of about 10,000 circular mils. A good rule for such coils and for the field magnet winding of dynamos is to allow 1,000 circular mils per ampere. This indicates that 10 amperes will be a good working current for the auto-transformer described in the December magazine, but 15 amperes are permissible for perhaps an hour, or greater currents for shorter periods. Just what current may be flowing in any given coil of an auto-transformer is difficult to predict—the inter-relations requiring a close analysis. Your safe procedure will be to have an ammeter available to test each circuit as required.

1961. **Dynamo Winding.** W. R., Eldred, Pa., says: Please tell me through your inquiry department the proper wire and winding to get the maximum output from a generator frame and armature of the following size. Also please advise if any greater output could be had by making a new frame and poles out of sheet-iron stampings that would allow of larger field coils. The present frame is cast iron, 2-pole Edison type, poles 1⅞ in. diameter and room for coil 3 in. long, with space of ¾ in. between the poles. The armature is 2⅜ in. diameter by 2 in. long, has 10 round holes 7-16 in. diameter inside of insulation. Shaft ½ in. diameter. The commutator is about 1 in. diameter with 10 segments. Ans.—You do not state what voltage is desired, but an illustrative case for about 20 volts will undoubtedly be of help to you. Wind armature with 32 turns per coil—64 wires per slot—with No. 20 d.c.c. magnet wire. If a few more turns can be gotten into the slots, all the better. Wind field magnet coils with No. 23 s.c.c. magnet wire, about 100 turns per layer and 12 layers. Nearly 3 lbs. will be required. Speed should be about 2,500 revolutions per minute. Any other desired voltage would be computed by using the number of turns of wire in direct proportion, but in your particular case the commutator has too few segments to withstand a higher voltage and insufficient surface to handle much more current than two No. 20 wires will deliver, say 4 amperes. It would not be worth your effort to rebuild one part of the machine, but rather make an entirely new one.

1962. **Dynamo Winding.** F. S., Stuyvesant Falls, N.Y., says: I have a small dynamo made by the C.&C. Electric Motor Co., New York. Armature is 2½ in. long and has 15 slots; commutator has 15 segments; length of spool for winding 2⅝ in., depth ½ in. Will you please print in your next copy of *Electrician and Mechanic* what size wire to use to wind for 70 volts 2 amperes to light four 16 c.p. 70-volt lamps? Ans.—As you do not state the size of slots, we cannot compute the number of wires you can get into them. No. 23 d.c.c. magnet wire will be the smallest permissible size to use, and you must put in as many as possible. Wind slots Nos. 1 and 8 half full, and leave out a loop for connection to the commutator; then without cutting the wire, wind a similar coil in slots 2 and 9, and bring out a second loop; similarly in the pairs of nearly opposite slots until on the second round the slots are completely filled, the beginning and end of the wire being then twisted together for the 15th loop. For field you should use about 3½ lbs. of No. 26 s.c.c. magnet wire, wound 125 turns per layer and in 20 layers.

1963. **Dynamo Winding.** G. R. A., Pittsburgh, Pa., says: I have the parts of an electric small power motor that has been burned out. What I want to know is, what size of wire and how much it would take to rewind this motor to act as a generator to have a maximum output of 8 or 9 volts and as many amperes as I can get. I wish to wind it as a compound wound machine. The armature is 2¼ in. in diameter and 2¼ long. It has 16 slots ¼ in. in diameter. The commutator has 16 sections. The two field pieces are each 2¼ in. in diameter and 1¼ in. long with plenty of room for winding. This dynamo must stand 10 hours of continuous running. What is the best speed? Ans.—If you wish the machine to run quietly and with little wear, we would suggest that the speed should not exceed 1,800 revolutions per minute. This, of course, means a lower output than if you drove the machine faster. You can wind the armature with No. 20 d.c.c. magnet wire, getting 9 turns per coil, 18 wires per slot; series portion of field winding can consist of two layers per coil of No. 14 d.c.c. wire, and the shunt portion of 14 layers of No. 23 s.c.c. wire. It would be a good plan to wind the field coils first, put them in place, and provide for experimenting a little in order to determine just what the armature winding should finally be. To do this, wind the armature with only one turn per coil—two wires in a slot—of any wire that may be available.

Bell wire is excellent, for its thick insulation will give immunity from "grounds." Clean off the insulation in the 16 places to permit temporary connection to the commutator. Excite the shunt portion of the field winding from some 8- or 9-volt source, say from storage batteries. Drive the armature at the desired speed. Measure the voltage produced by the armature. Say 1 volt is indicated. Then for the final winding you will require nine times as many wires per slot, or the suggested 18. Any other number of volts can be secured by using the proportionate number of turns, but the field winding would then have to be altered to fit.

1964. **Induction Motor.** F. W. W., Portland, Ore., asks: (1) What is the size and number of turns of wire on the core of a General Electric phase splitter for a ½ h.p. 110-volt 60-cycle 7½-ampere induction motor? (2) What is the size of the core? (3) What effect will a 60-cycle current have on a 133-cycle recording wattmeter? Ans.—If you have no means of making sheet iron in the form regularly employed for such devices, you can readily make a coil in more elementary manner that will permit some adjustment to fit your particular conditions. Make a wooden spool by first boring a hole about 2 in. in diameter in a block of wood 3¼ in. square and 6½ in. long. Mount this upon an arbor and turn the inner portion to a diameter of 2¼ in., leaving flanges at the ends about ⅜ in. thick and as large in diameter as possible. Wind the space full of No. 14 d.c.c. magnet wire. Provide a coil of tinsmith's annealed iron wire. Pull it out in long lengths, such as may be convenient, say 50 to 150 ft., and forcibly stretch it. This act will leave the wire perfectly straight, and it can then be cut into lengths, say of 8 in. Fill the hole in the spool with the wires, and try the device with your motor. If motor starts too sluggishly, and the current does not seem extreme, remove some of the iron from the spool. If start is good, but current seems extreme, cut some longer wires that can be made to extend over the outside of winding on spool and complete the magnetic circuit. Sheet iron can be used as a substitute for the iron wire.

1965. **Dynamo Construction.** C. M. C., Fulton, N.Y., has a variety of armature and field magnet punchings, the former being 3$^{11}/_{16}$ x 2½ in. in diameter, with 37 round holes ¼ in. in size, the other a trifle over 3$^{11}/_{16}$ in. inside diameter and 7 in. outside, cut for 4, 6 or 8 poles, or with 24 internal slots. He wishes to make a dynamo that will give 6 volts and 8½ to 15 amperes, and asks what construction will give the best results, speed to be 600 to 1,200? Ans.—It will not be practicable to use more than four poles in so small a machine, and the sheet iron for the field magnet should be clamped between iron castings of the same shape as the sheets, but perhaps ¼ in. thick, else there will not be sufficient residual magnetism to permit the machine to be self-exciting. For the armature, however, solid iron must not extend to the slots. If the openings to the slots are too small 2¼ in. Each slot should receive 8 wires, and it is possible to get in that number with No. 16 d.c.c. in size, but you had better try it to make sure, and if you foresee difficulty, use No. 17 wire, though with that smaller size you will not be able to draw 15 amperes without undue heating. Armature winding will be of the series type, similar to that employed on railway motors. Formed coils, though "random" wound must be made, the two straight sides being about 2½ in. long, and the ends diamond-shaped, making angles with these sides of about 45 degrees, the leads being brought out at these angles. A given coil will extend from slot No. 1 to slot No. 10, and so on, each coil consisting of four turns, making eight wires per slot, when the sides of the two different coils are disposed in the same slot. The two ends of a given coil connect to segments of commutator that are most nearly opposite. Connect in all the bottom wires first, then there will be least trouble in locating the remaining ends. Field should be a plain shunt, consisting of No. 20 s.c.c. wire, between 4 and 5 lbs.—all you can get on.

1966. **Dynamo.** R. T. D., Lexington, Va., says: (1) I desire to know what size dynamo would it take to make electricity enough to run a $1/80$ h.p. motor of 110 volts 60-cycle over 2,000 ft. of copper wire with the return wire or track of No. 12 or No. 9 iron wire. (2) What size should the copper wire be to carry the current at 110 volts pressure, and what size iron wire for the return to dynamo? (3) Could the dynamo be tuned by hand or would batteries be better? How many and what kind would be best? (4) Would be glad to know of some company where I could get a very small locomotive or motor to run on a single wire suspended similar to the telephone used at the Arnold Print Works at North Adams, Mass., as described in the May, 1912, number. Ans.—(1) and (2) To undergo the expense of such a transmission line for the sake of delivering $1/80$ h.p. seems rather unwarranted, but of course it can be done. Such small motors may not have an efficiency above 25 per cent., so the amount of current transmitted would have to be on the basis of delivering about $1/7$ h.p. As the 110 volts is the pressure at the supply end, the pressure at the receiving end will be less, due to the line losses. These losses will be almost entirely due to the ohmic resistance in the copper portion of the line, but in the iron portion there will be in addition a reactance loss due to the alternating character of the current quite as important as the ohmic. To use smaller than No. 12 B.&S. copper wire would involve mechanical weakness, and 2,000 ft. of this size has a resistance of about 4 ohms. Iron wire is estimated by the Birmingham wire gauge; and 2,000 ft. of No. 12 of the best quality would have a resistance between 6 and 8 ohms. The reactance would have the effect of increasing this figure to 10 or 12 ohms. The total line resistance would then be perhaps 15 ohms. Considering the fact, too, that such a motor

The expression "return circuit" is not altogether appropriate, for the alternating current goes as often by one wire as by the other. (3) We do not understand what you mean by "tuning" the dynamo. What dynamo? (4) Address the Carlisle & Finch Co., Cincinnati, O.

1967. **Transformers.** W. S. P., Winchester, Ind., wants to make two small stepdown transformers to operate on a 110-volt 60-cycle supply, one to light 25 2 c.p. 6-volt carbon filament miniature lamps, the other to ring 8 to 10 common vibrating bells. He asks for dimensions of the cores and for data as to the windings. Ans.—Considering the transformers to be of the "shell" type, the data for the larger one can be: width of tongue of core, 2 in., stack of iron 2 in. high; secondary winding, 28 turns of two No. 8 wires in parallel; primary, 460 turns of No. 23 wire. Smaller size, iron tongue 1 x 1 in., and 2 in. long. Secondary winding, 120 turns of No. 20 wire; primary, 1,800 turns of No. 28. In both cases the section of iron outside the winding should be one-half that of the tongue, but in consequence of two such sections comprising the magnetic circuit, there is no constricting of the magnetic path. The size of iron in these outer portions will then be 1 in. and ½ in. wide, respectively. You can make the iron portion smaller, if you prefer, if you will increase the number of turns in the inverse proportion. If you do not intend to operate all the lamps or bells at the same time, smaller transformers than these will suffice.

1968. **Electrical Lighter.** R. M., Manchester, N.H., says; What is the composition they use in the electrical cigar lighter? It is some kind of a cement that I mean, and what kind of wire do they use and how is it connected and insulated? Ans.—As I am not a smoker I do not catch on to the particular piece of apparatus the writer has in mind. By "cement" does he mean the sealing of tar and resin used on the top of a dry cell? The wire used is undoubtedly platinum, heated by the passage of the current. I saw a jimcrack of this sort some time ago, and maybe this is the sort asked about. If need be I will investigate further.

1969. **Information on Controllers.** J. K., New York City, says: I would like to know if you have any book on controllers for elevators, printing presses, etc., and if you have any, what the price will be. Ans.—We do not know of any regular publications on this subject, but you will find that the manufacturers of such apparatus will supply you with a very large variety *gratis*. Address the General Electric Co., Schenectady, N.Y., The Westinghouse Electric & Manufacturing Co., Pittsburgh, Pa., the Cutler-Hammer Co., Milwaukee, Wis., The Otis Elevator Co., Yonkers, N.Y., and various other firms that advertise in the electric periodicals.

1970. **Casting.** A. C. H., Seymour, Mo., says: (1) What is the size and material of the sample of wire enclosed, and is its resistance high enough to be of any use in the construction of heating devices such as are described from time to time in *Electrician and Mechanic*? (2) Can old receiver shells, transmitter mouthpieces and other scraps of composition be remelted and cast in molds like the metals? (3) How are the plaster of Paris statuary made so as to be hollow? Ans.—(1) A chemical analysis would be required to give complete assurance of the material, but it appears to be ordinary "high" brass, that is, "hard" drawn. The size is No. 24 B.&S. gauge, and the resistance of the 20 in. length is about 2 ohms. This is altogether too low for use in heating devices. You will get valuable information on the proper sort of wire for the purpose in mind by addressing the Driver-Harris Wire Company, Harrison, N.J. (2) Unless you have a very large quantity of the material, and business in sight is of sufficient volume to require the continuous services of a chemist, you will find the recovery of hard rubber scrap inadvisable. Be satisfied to sell it to a junk man. (3) Differing from the method of making castings, the statues are gradually formed by working. Of course the mold is previously prepared in a shape to give the desired outside appearance. Its own exterior may be of crude and hardly recognizable form. Imagine the structure to be hollow like a barrel open at one end, and you were to make a hollow reproduction of the interior configuration. You could mix a quantity of the plaster and hastily spread it over the interior, rolling and tipping the barrel until the whole was evenly covered. If still thicker was wanted, stock could be added to any desired extent. After drying and baking, the hoops could be cut, when the staves would fall away, leaving a cast of the exact appearance of the interior desired. The principle you can readily apply to any desired object.

1971. **Dynamo Construction.** H. O. S., Toledo, Ohio, says: I have a toy motor (Knapp Type A), three-part commutator. Would like to know if I could rewind and use as a toy dynamo. If so, please tell me how. Ans.—All "good" motors can also be used as generators, but the one to which you refer is necessarily of inefficient design, and it will fail to generate for the reason that the entire output of the armature is insufficient to energize the field magnet. Still, it will be interesting to make some experiments. The motor has a series field magnet winding, therefore as a prime condition for its becoming a generator it must be driven in a direction *opposite* to that in which it runs as a motor. In case of motors with shunt-wound field magnets, the *same* direction for generating is required as it exhibits when running as a motor. Further, for the case of a series machine, the resistance of the external circuit must be low. The lowest you can get will be to place the machine on a short-circuit. Drive the armature as fast as possible without ruining it, and see if the iron of field exhibits any increased magnetism. If it does, this is evidence that machine is generating, but the chances are that when you try to introduce any external resistance, the generating will cease.

1972. **Storage Battery.** A. N., Toronto, Ont., Canada, says: With reference to the enclosed which appeared in your September issue last, I should be glad if I might ask two or three questions. Would the capacity be increased by using four lead cylinders in each jar or does the lead packing achieve the same object? Would the cylinder next to the jar be negative and the inner one positive, and if four plates were used in each cell would it be negative next to the jar, then positive, negative and positive? How shall I form the cells? What would be the

charge and discharge rate and probable capacity of two cells about the size of a quart Daniel each? Ans.—The article to which reference is made was taken, as acknowledged, from the *Scientific American*. The directions are good as far as they go, but curiously, they stop too soon, for after exactly following them, all the builder would get would be *one* electrode per cell. There certainly must be *two*. Another pair of concentric lead cylinders should be made but of such smaller diameter as will permit placing within the former, and leave about ½ in. space between them. Instead of filling the gap between the plates of each pair with finely divided metallic lead, you will get a much quicker "formed" cell if you use the oxides of lead, namely, litharge, or yellow lead, for the electrode that is to be the negative—preferably the outer one—and red lead for the other. The paste should be formed by mixing only about half a teacupful at a time, in dilute sulphuric acid—5 to 1—and ramming it down in place with a stick. After drying, dip the plates momentarily in dilute acid daily for several days until the paste thoroughly "sets," then it will not loosen when final immersion is made. You will do well if you provide the outer plate with ears that can hook on to the upper edges of jar, so that lower edge will be at least 1 in. from bottom of vessel. Positive can stand directly on bottom, but will not thereby be in danger of short-circuiting with the sediment. You can permanently connect six or seven gravity cells to two storage cells of this sort, and in the course of several months the charging would be effected. If you use three storage cells, ten gravities will be needed. Of course for more serious work, a dynamo will be more economical.

1973. **Magneto.** C. B. T., West Middlesex, Pa., says: I have a Remy magneto, Type W2, which I took from an old automobile. What would be its voltage and amperage at 2,500 revolutions, and would it light an electric lamp? Ans.—Ordinarily an ignition magneto machine gives 4 to 8 volts, but you will understand that strength of magnets and speed of rotation are both concerned. It is common experience that the magnets have occasionally to be re-energized. As your machine was taken from an old automobile the chances are that the magnets are weak. We can hardly conjecture what the voltage would be, but it is such a simple test to make the actual trial, we would suggest that way of finding out. Put several 6-volt lamps in series, and find out how many to include to give normal brilliancy. If three in series burn dimly, while two burn too brightly, then you should get some standard 15-volt lamps for regular use.

1974. **Dynamo Construction.** E. H., Woonsocket, R.I., wishes to change a 1 h.p. Waverley automobile motor into a shunt generator. He has rewound the six field coils with No. 22 s.c.c. wire, 650 turns per coil, and though he has driven the armature at a speed of 1,200 revolutions per minute, it fails to generate. What can be done to make the change a success? Ans.—The armature of this particular motor is series wound, and can have two, four or six brushes, the ordinary equipment being with four, spaced, of course, 60 degrees apart, the lower semicircle of commutator being free in consequence of its comparative inaccessibility. You may find it advisable to utilize all six possibilities. Three alternate brushes are to be connected to furnish one terminal, the other three similarly providing the other terminal. No. 22 wire appears to be correct for the field winding, for since the average turn is about 9 in. in length, you have about 500 ft. of wire per spool, and thereby a resistance of about 8 ohms. Six such coils in series, offering 48 ohms, will permit a current of .8 ampere to flow when normal voltage, 40 volts, is acting. This means about 800 circular mils per ampere, which is the limit of safe running. The position of brushes is fixed by the construction of the machine, so you have no method of shifting them. In consequence of the sort of formed coils employed, the neutral points for the brushes are directly in line with the centers of poles. The segments on which the brushes touch connect with coils that lie midway between the poles—an imperative condition. Perhaps you have connected the field coils in a wrong manner. Your sketch is rather ambiguous. Test them with a compass, separately exciting the fields, armature being removed. Of the ends of field coils, connect first two inside ends, then two outside, and so on, finally leaving two outside ends to attach to the armature terminals. If these tests do not avail, separately excite the field magnets from any available source—not using, however, more than .8 ampere, and drive armature at the proposed speed, and see what voltage is produced. If voltage is in excess of the pressure impressed upon field terminals, the machine ought to be self-exciting; if less, then the case is hopeless at that speed, and the only recourse will be to drive the armature faster. In general, it is difficult to make a low-voltage machine self-exciting when carbon brushes are used. You might demonstrate this point by fitting the machine with temporary woven-wire copper brushes. Two brushes will determine the operation as well as the four or six.

1975. **Storage Battery.** J. O., Elizabeth, N.J., says: Will you please give me a design for building a storage battery to light from 20 to 25 miniature incandescent lamps of 3½ to 4 volts, one that will last from 6 to 10 hours without having to be recharged? Also can you tell me the best place to buy the material for same? And I would like to know how much it would cost to make such a battery. Ans.—The July, 1911, issue of *Electrician and Mechanic* was the "Storage Battery" number, and we believe you will find much profit in reading it. Directions are given for making cells, but you will find additional information in Watson's book on the subject. As you do not state what candle-power of lamps you propose to use, or whether they are to be of the carbon or tungsten sort, we cannot suggest what size and number of plates you will require. For 4 volts you will need at least two cells, but if the lamps are to be at some distance from the battery, we would suggest that you wire the circuits so as to have several lamps in series. This will permit you to use smaller wires, but with the accompaniment of more cells of a small size than otherwise. If you can give more explicit specifications, we will be pleased to advise you further.

1976. **Motor Parts.** W. R. M., Spokane, Wash., says: Where can I purchase stampings

and finished parts to make a 1/20 h.p. induction motor? How and with how many turns of what size wire should this motor be wound? About what watt dynamo would this motor run and where could I purchase such a dynamo? Ans.—Perhaps F. E. Averill, Buffalo, N.Y., could supply them. Do you mean to drive a direct-current dynamo with this motor? It certainly would be very a small one, and you might find your need better supplied by use of batteries. Ten cells of gravity battery permanently connected to three small storage cells would be practical and always ready.

1977. **Meter Reading.** J. R. T., Itasca, Tex., says: The four dials of a recording electric light meter are numbered 1,000, 100, 10 and 1, respectively. At a particular time the fingers indicated 0, 3/4, 8 and 9, in same order. How should the meter be read in kilowatt-hours, and at 20 cents per kilowatt-hour, what should be the charge? Ans.—A complete revolution of the several fingers would mean, respectively, 1,000 k.w. hours, 100 k.w. hours, 10 k.w. hours and 1 k.w. hour. As the last one points on the 9, it has not made the complete revolution, therefore indicates 900 watt-hours—.9 k.w. hours. The next dial indicates 8 k.w. hours, the next between 70 and 80 k.w. hours, the total reading being then, 78.9 k.w. hours, and at the rate of 20 cents, the charge would properly be $15.78.

1978. **Armature Winding.** Mr. P., Cleveland, Ohio, asks for directions for winding a smooth core drum armature fitted with a 10-part commutator, dimensions being 2 in. in diameter and 3 1/8 in. in length. What will be its output as a generator when driven at a speed of 1,500 revolutions per minute? What is a good book describing construction of armatures? Ans.—There was a good description, illustrated with cuts, of such armatures in the November, 1908, issue of *Electrician and Mechanic*. In your case the fiber end plates should be divided into 10 parts, and cut with a hack-saw into which slots fiber pegs can be driven to hold the wire. For such a small machine, especially from its being your first, we would advise that you try to put on but two layers. The result will give a low-voltage machine, but will avoid difficulties inherent in a four-layer winding. Use No. 20 d.c.c. magnet wire; there will be room for 14 turns between pegs, and you can pass seven on each side of the shaft. With a suitably strong field magnet the pressure produced at a speed of 1,500 revolutions should be 10 volts, but 2,400 revolutions would not be too high for so small a machine. Current output could safely be 4 to 5 amperes. A good publication is gotten out by a concern in your own city—The Cleveland Armature Works—and we would advise you to examine a copy.

1979. **Wireless Instruction.** H. V., Port Whitby, Ont., says: (1) Could you tell me the cheapest and the best way to learn "Wireless Telegraphy," how long it would take, etc.? (2) Does the Marconi Co. or any other telegraph company take learners? (3) Does the wages paid to wireless operators include board? Ans.—(1) The best way to learn the wireless art is first to become a proficient operator, at least become sufficiently familiar with the Continental code so that you can send and receive at the rate of say 10 words per minute. You should then enter some school of wireless telegraphy where you can secure technical training and instruction in the methods of procedure in handling business by a commercial company. If you are absolutely unfamiliar with the Continental code you would require ten months of daily practice to become a good operator. (2) The Marconi Company accepts learners at their New York School. (3) The salary paid wireless operators aboard ship of course includes food and quarters free of charge. In addition to the salary paid the Marconi Company of America pays a 10 per cent. commission on the receipts of the particular ship on which the operator sails.

1980. **Castings.** T. M., Wilmington, Ohio, says: Will you kindly advise me regarding an article in the January, 1911, *Electrician and Mechanic*? Under the department "The Modelmaker" a description and construction of a "Model Two-Cycle Motor" is given by C. F. Brierley, the article being taken from the *Model Engineer*. Where can I buy the castings in the rough or the finished bare motor? If they come from England, would they come in "duty free," or if a duty, how much? What would the castings cost, also the finished engine? Ans.—Perhaps Palmer Bros., Mianus, Conn., The Carlisle & Finch Co., Cincinnati, Ohio, or Mr. Houghton, of Waltham, Mass., would be able to supply the want.

1981. **Motors, etc.** L. R. B., Jeanette, Pa., says: (1) What are the disadvantages of the variable speed reversible alternating current motors, having laminated field, and sectional commutator with brushes, as is required with direct-current motors? (2) Where can I procure some substance that is a magnetic insulator; that is, a substance that magnetic lines of force will not penetrate? (3) What is the approximate cost of the materials to construct a wireless transmitting and receiving set suitable for about five miles' work? Ans.—(1) Such are known as "repulsion-induction" motors, invented by Latour in France, and Winter and Eichberg in Germany. They have a higher starting torque than simple induction motors, and in addition have the qualification of being fitted to run at speeds other than those near to synchronism. Thus a 4-pole 60-cycle motor would have its synchronous speed at 1,800 revolutions per minute, and at full load might run at 1,700 revolutions, but the exact speed would vary with the size of the motor. A machine of the type about which enquiry is made could be run at perhaps any speed between 1,200 and 2,000 revolutions. Such a variation is very desirable, say for operating printing presses. The efficiency of such motors, by reason of the greater resistance in the windings, is somewhat lower than is realized with the induction type. This means that more current may be required to operate it than the corresponding direct-current motor. The "power-factor," however, is higher, that is, it is free from the lagging current feature unavoidable with induction motors, therefore interferes less with the constancy of the voltage on the supply circuits. (2) In the same sense that glass is an insulator to electric currents there is no corresponding substance that is an insulator to magnetic lines of force. Iron is the best preventive for shielding instruments

from the effects of outside magnetic disturbances. When accurate work is being done with galvanometers they are inclosed in an iron cage to keep out any outside magnetic disturbances. (3) The cost would depend on the type of set constructed. If a transformer was constructed the total cost of both sets should not exceed $40.00.

1982. **Wireless Telegraph Aerial.** R. F. A., Carmine, Tex., says: As I wish to erect a wireless telegraph aerial, therefore I beg to ask you a few questions about same, as follows: (1) The above aerial is to be of the inverted "L" type, and to be composed of six phosphor bronze wires (stranded) placed on spreaders 2 ft. apart, and in turn supported by two masts each 56 ft. high and 150 ft. apart. Is the above aerial proportioned correctly? (2) In what direction should an aerial run to get best results, in a north-south or east-west direction? Ans.—(1) It would be better, but not absolutely necessary, to increase the distance between wires to 3 ft. (2) That would depend on the direction in which you desired to do your best work. Have the open end opposite from the direction which you desire to do your best work.

1983. **Dynamo Construction.** Mr. W. F., Des Moines, Ia., asks: Please find enclosed sketch of a D.C. dynamo, and write me if the proportions are good for a machine that will generate 35 volts and 10 amperes at a speed of 2,000 to 2,500 revolutions per minute, and if they are good, tell me the size of wire and number of turns on armature and field and what kind of winding would be the most suitable for my purpose. I intend to build two of those machines, one for running incandescent light and the other charging storage battery at the same time, one engine running both. What part of a kilowatt will one machine be? Dimensions of the machine are given in the sketch. Ans.—The design is very good. Field winding should consist of about 2½ lb. per spool of No. 23 s.c.c. magnet wire, giving about 1,300 turns. The shape of coil will have to be bent in order to fit the curved place inside the circular magnet yoke. Armature should be wound with No. 18 d.c.c. magnet wire, about 30 wires per hole—15 for each half-winding. For your purposes plain shunt winding will be the most satisfactory, and if both machines are wound alike they will be exactly exchangeable—a convenience in case of accident. In fact, you ought to make one machine do most of the work. 10 amperes at 35 volts give 350 watts, about one-third of a kilowatt, or one-half an electrical horse-power.

1984. **Oil Furnace.** J. E. T., of Plessisville, Canada, asks: (1) What is wrong in a crude-oil furnace made especially to heat rivets in a boiler shop? It runs 2 or 3 minutes and stops, and when we rap on the pipe of the burner it begins again to heat and runs very well for a short time. (2) Is there any way to increase the pressure in a hot-water heating system? Does the Honeywell system with mercury increase the pressure? Ans.—(1) Perhaps you are heating the oil before it reaches the burner, that is, you are "pre-heating" it. This should not be done, for the result is to cause a thick deposit to form in the tube. The spray or jet of oil should be at its ordinary temperature until mixed with the jet of steam or hot air. (2) Yes, by increasing the height of the pressure pipe. The Honeywell system is the equivalent of this, only by the use of mercury the actual length of the pressure pipe is reduced. Increasing the pressure sometimes improves the working of the system from the reason that a somewhat higher temperature of the water is then possible. Naturally the higher temperature is beneficial, but partly for the reason that a more rapid flow, especially in otherwise nearly stagnant parts of the circuits, is realized. An increase of 10 lb. in pressure would probably be a safe limit.

1985. **Blitzen Receiving Transformer.** R. A. S., Sunbury, Pa., asks: Would you please inform me, either by letter or through your magazine, if the Blitzen receiving transformer has but one winding on the secondary or is there more than one layer, also its construction. Ans.—The Blitzen receiving transformer is wound in two grooves, the primary being 4 in. and the secondary 3 in. in diameter. The primary has a total of 90 turns with taps taken off every three turns. The secondary has a total of 100 turns with twelve taps.

1986. **Motor Efficiency.** J. O., Chatham, Can., asks: (1) How is the horse-power of a motor computed from readings given by a curve-drawing ammeter? The particular conditions are: three-phase alternating current supplied at 480 volts and 60 cycles, current in one main being 18 amperes. Please work out the solution. (2) How is the power factor determined? Ans.—This problem cannot accurately be solved unless you have the information sought in your second question, and to answer the second you must have a wattmeter. If, however, your motor is loaded to about its full rating, you will not be far from the truth in considering, the power-factor as 0.90, though it may not be above 0.85. Considering the current that flows in each of the three mains to be 18 amperes, the total effective current will be found by multiplying by the square-root of 3,—1.732, giving 31.1 amperes. Multiplying this by the number of volts, you get 15,000, the apparent number of watts, but really the "volt-amperes." If you had a wattmeter in circuit—even if it were of the recording sort, you could divide its reading by this 15,000 and get the power-factor. If the motor is operating with a power-factor of 0.9, multiply the 15,000 by this fraction, and you get 13,500 as the true or actual watts. Of course the motor does not have a mechanical efficiency of 100 per cent., for there are losses due to heating in the windings, the core, and the bearings, etc. Calling the efficiency as 90 per cent., the number of watts that are effective for producing power will be found by multiplying by this fraction, giving 12,750. Since there are 746 watts in a horse-power, dividing by this number, you will get 17.1 as the horse-power which the motor is probably exerting. This number is so close to the 18, which was the number of amperes stated, that it is a common rule in considering 3-phase 500-volt motors below 25 in horse-power, to estimate one actual horse-power per line ampere.

1987. **½ Kw. Transformer.** In the February issue under No. 1926 the answer to the second question should read, "Normally about 0.04 mf. is used, but with the requirement of a 200-meter wave-length it is impossible to use much over 0.01 mf." These figures were erroneously printed as .004 and .001 respectively.

TRADE NOTES

A NEW SHAPED TOOL for Telephone, Telegraph and Electric Light Workmen

Up to the present time it has been the custom of all tool manufacturers to follow and adhere to "so-called" standard designs and methods of shaping pliers. The regular bell hangers' plier as well as the standard side cutter that the lineman uses have been standard staple shapes for many, many years.

Tools of this kind have never been entirely satisfactory to the workman. One manufacturer will pull in the handles ¼ in., another would spread them ¼ in., but the result was always the same, an uncomfortable unreliable and unsatisfactory grip. The plier handles would raise blisters on the palm of the hand. The handles in another case would be so close that in cutting wires the knuckles would be pinched and bruised; still in another case the shape of the handles would be such that full pressure could not be put on the handles at all.

Noting this universal defect, the Smith & Hemenway Co., 150–152 Chambers St., New York, the manufacturers of "RED DEVIL" tools, undertook to build a plier on scientific principles. Principles that were so radical from the usual methods that it was many months before they demonstrated to several experts that the only correct way to make a plier was on scientific lines, just the same as an architect draws plans for a 40-story tower building or an engineer goes into the technical details of the current-carrying capacity of a piece of electrical copper with several bends or breaks in it. The result is an entirely new-shaped handle, as shown in the illustration. Follow closely the lines of these handles, note the peculiar bend, note the narrowness toward the head. Note the swell in the middle and offset at the end.

Look then at your own hand as you would grip a tool of this kind in actual use. Does it conform? It does, scientifically, accurately and comfortably, and we are assured by the Smith & Hemenway Co. that the feel of their scientifically-shaped handles is just as satisfying as a well-fitting glove. No possible chance to pinch the knuckles or fingers, no possible way to raise blisters on the palm of the user's hand, no matter how constant the use of the tool may be. Moreover, it has been the usual custom to knurl or check the handles, an unsatisfactory method. In these scientifically-made "RED DEVIL" Pliers knurling—or checking—is eliminated entirely, and scientific principles are again employed by "Dentyne Milling" them, a method structed on these scientific principles, and our readers are requested to apply at any tool or hardware store in any city or town in the United States and examine these new and well-known electrical tools.

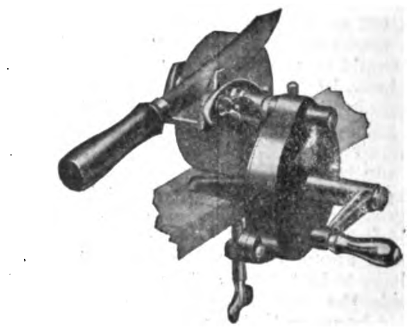
There are over 1,700 kinds, styles and sizes of Pliers alone as well as over 1,500 other tools and specialties that bear the "RED DEVIL" trademark.

So A Woman Can Use It

No matter how mechanically perfect any article may be, if it is not adapted to being used by the housewife with no more than ordinary feminine mechanical ability, it is not adapted to the household. This would be particularly true with fast-cutting grinders on which a woman might be afraid of injuring the tool she was trying to sharpen.

The small grinder here illustrated has been put out by the Luther Grinder Mfg. Co. for a number of years. However, the new tool rest that they have just put on it makes it far more valuable for home use than it has ever been before.

This consists of a special guide coming up on each side of the grinding wheel. The knife is sharpened on the side face of the wheel, the guides insuring that just the proper bevel is maintained. The wheel turns from the operator, which ob-

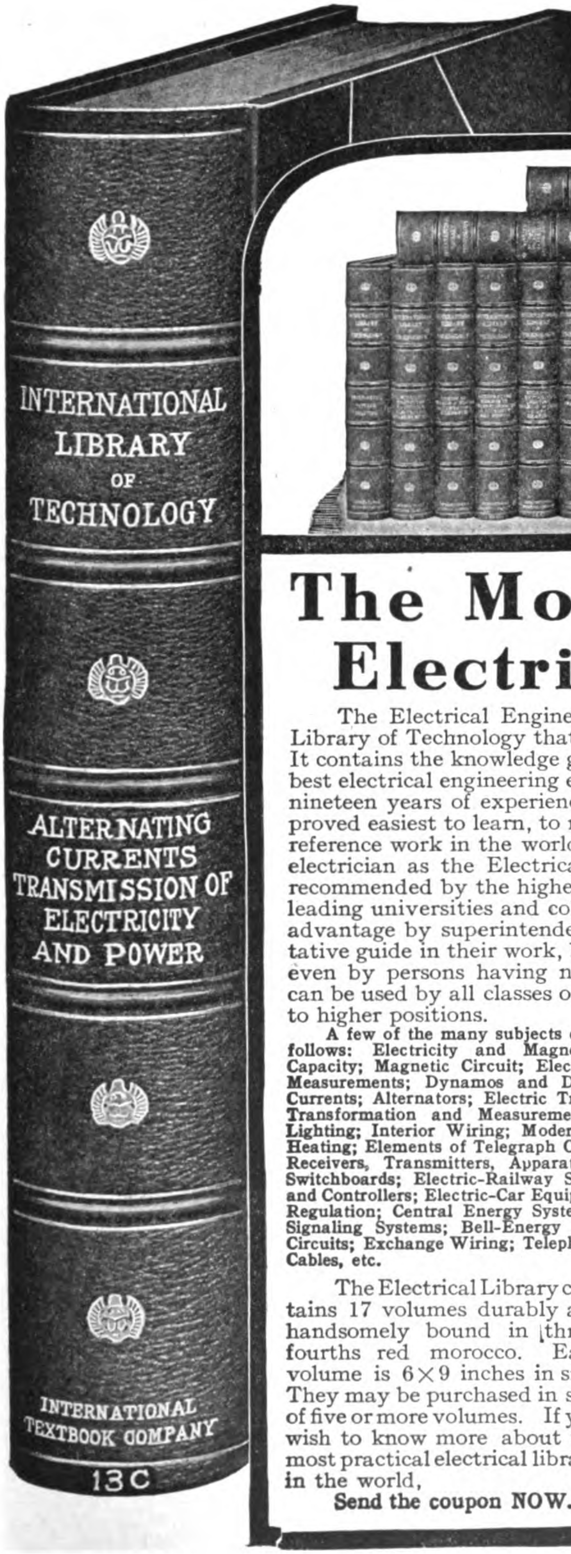


viates any danger of the knife's being jammed between the guide and the wheel, as the wheel continually lifts the knife. Sharpening it on the side face of the wheel gives a finer, smoother edge than could be otherwise attained. It leaves it also with no graining, especially if the knife is moved forward and back while being sharpened.

This guide is also especially adapted for scissors so they can be easily held at exactly the proper bevel. Altogether it makes an ideal sharpening machine for the home.

Reliable Wireless Firm

Our good friends, the Wm. J. Murdock Co., of Chelsea, Mass., are getting out excellent wireless



The Most Practical Electrical Library

The Electrical Engineering Library is part of the International Library of Technology that cost $1,500,000 in its original preparation. It contains the knowledge given from the life experience of some of the best electrical engineering experts in the country, edited in a style that nineteen years of experience in publishing home-study textbooks has proved easiest to learn, to remember, and to apply. There is no other reference work in the world that so completely meets the needs of the electrician as the Electrical Engineering Library. The volumes are recommended by the highest authorities and are used in nearly all the leading universities and colleges. Not only can they be used to great advantage by superintendents, foremen, and engineers as an authoritative guide in their work, but since they can be so clearly understood even by persons having no knowledge of higher mathematics, they can be used by all classes of electricians that are desirous of advancing to higher positions.

A few of the many subjects contained in the Electrical Engineering Library are as follows: Electricity and Magnetism; Electrodynamics; Electrical Resistence and Capacity; Magnetic Circuit; Electromagnetic Induction; Primary Batteries; Electrical Measurements; Dynamos and Dynamo Design; Direct-Current Motors; Alternating Currents; Alternators; Electric Transmission; Line Construction; Switchboards; Power Transformation and Measurement; Storage Batteries; Incandescent Lighting; Arc Lighting; Interior Wiring; Modern Electric Lighting Devices; Electric Signs; Electric Heating; Elements of Telegraph Operating; Principles of Telephony; Telephone Circuits, Receivers, Transmitters, Apparatus, Bells, Instruments, and Installation; Magneto-Switchboards; Electric-Railway Systems; Line and Track; Line Calculations; Motors and Controllers; Electric-Car Equipment; Multiple-Unit Systems; Efficiency Tests; Energy Regulation; Central Energy Systems, Main and Branch Exchanges; Common-Battery Signaling Systems; Bell-Energy System; Bell Trunk Circuits; Bell Toll and Testing Circuits; Exchange Wiring; Telephone Cables, etc.

The Electrical Library contains 17 volumes durably and handsomely bound in three-fourths red morocco. Each volume is 6×9 inches in size. They may be purchased in sets of five or more volumes. If you wish to know more about the most practical electrical library in the world,

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BOOK REVIEWS

Radioactive Substances and their Radiations. By E. Rutherford, D.Sc., Ph.D., LL.D., F.R.S. Cambridge: at the University Press. New York: G. P. Putnam's Sons, 1913. Price $4.50 net.

Professor Rutherford, now of the University of Manchester, England, but formerly of Montreal, is one of the chemists best known in connection with the important subject of radioactivity. With his associate, Professor Soddy, he has been engaged in work on this subject for many years, and in this scholarly volume of 700 pages he has given a most interesting and thorough compilation of the known facts in regard to radioactivity and the substances which produce it. The subject is one of such enormous importance to present-day science that no scientist can afford to be without a book of this character in his library.

Electroplating. A treatise on the electrodeposition of metals with a chapter on Metalcoloring and bronzing. By William R. Barclay, A.M.I.E.E. and Cecil H. Hainsworth, A.M.I.E.E. Illustrated. New York, Longman's Green & Co. Price $2.10 net.

Most handbooks on electroplating have been written by practical workers who relied upon rule of thumb methods acquired by them in their years of experience. While such methods are usually trustworthy and yield good results in the hands of those accustomed to them, they have often offered difficulties to others, and not being founded upon scientific principles, a search for the source of trouble is made blindly. The present book is based on exact electro chemical experimental work, and the principles on which the authors' processes depend are so thoroughly set forth that the student who has mastered the introductory chapters will have no difficulty in tracing to their source any difficulties which may arise.

The Gasoline Engine on the Farm. By Xeno W. Putnam. Fully illustrated by 179 carefully selected engravings of great value to all interested in the efficient and economical application of farm power. New York, The Norman W. Henley Pub. Co., 1913. Price $2.50.

A practical, comprehensive treatise on the construction, repair, management and use of this great farm power as applied to all farm machinery and the farmer's work indoors and out. This treatise, because of the simple, nontechnical exposition of mechanical principles, is especially valuable to those without previous mechanical knowledge who wish to become thoroughly familiar with the operation and care of gasoline engines, tractors and auxiliary devices. This is a complete worker's hand-book on the internal combustion motor and its many applications in modern farm life. Considers all the household, shop and field uses of this up-to-date prime mover and includes chapters on ...on, power transmission, and the ...ower plant with re-

Elementary Principles of Electricity and Magnetism for Students in Engineering. By Robert Harbison Hough, Ph.D. and Walter Martinus Boehm, Ph.D. New York, The Macmillan Co., 1913. Price $1.10 net.

This little book is intended as a work for home study as a text-book for college students to be used in conjunction with a set of lectures properly illustrated with experiments. The amount of mathematics required for its proper comprehension is considerable, comprising at least a working knowledge of mechanics and trigonometry, while the student who does not at least accompany the study of the work with that of calculus is likely to be placed at some disadvantage. For students of these qualifications it will be found an excellent book, as the treatment is both concise and lucid.

Practical Mathematics for the Engineer and Electrician. By Elmer E. Burns and Joseph G. Branch, B.S., M.E. Chicago, The Joseph G. Branch Publishing Co., 1912. Price $1.00.

This books is not intended as a course in arithmetic, but as a collection of various tables and rules of everyday importance to the operating engineer and the working electrician. It covers a large variety of mathematical subjects which mechanics of these classifications must be familiar with to pass examinations and to meet the daily requirements of an expert in these lines, and should prove extremely useful to such workers.

The Slide Rule and Logarithms Simply Explained. By J. C. Peebles, E.E., M.M.E. Chicago, The Joseph G. Branch Publishing Co., 1912. Price 50 cents.

The slide rules are such a handy method of the application of mathematics and offer such a ready means for instantly solving without calculation many simple problems, especially those of multiplication, division, involution and evolution, that it is surprising that more people do not habitually use it. The accuracy is sufficient to three or four places of decimals, and the amount of time saved by the use of this tool is so great that every electrician should be familiar with it. This book gives a thorough understanding of the use of the rule and illustrates several of the more common commercial logarithms.

Opera Stories. Most persons attending an Opera wish to know only its story without reading its entire libretto. "Opera Stories" is published for this reason, and contains, in a few words, the stories (divided into acts) of 174 Operas, 6 Ballets and one Mystery Play; also portraits of leading singers. Henry L. Mason, Boston, 1913. Price 50 cents.

The great popularity of Grand Opera throughout the United States, and the fact that not only do all the large cities have seasons at the present time, but that many of the smaller places are visited by both the great companies and by less important stock companies, makes a book of

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Russell Sage said: "There is a common fallacy that, while for legal advice we go to lawyers, and for medical advice we go to physicians, and for the construction of a great work, to engineers—financing is everybody's business. As a matter of fact, *it is the most profound and complicated of them all.*"

So let me give you just a glimpse of the valuable investment information you will get in my six big issues, "The Little Schoolmaster of the Science of Investment," a guide to money-making:

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How to Judge a Business Enterprise.
Where New Capital Put Into a Corporation Really Goes.
"Watering"—Its Significance.
Idle Money vs. Active Money.
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Investment Securities Are Not Investment Opportunities.
The Actual Possibilities of Intelligent Investment.
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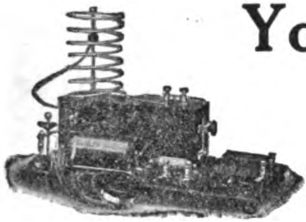

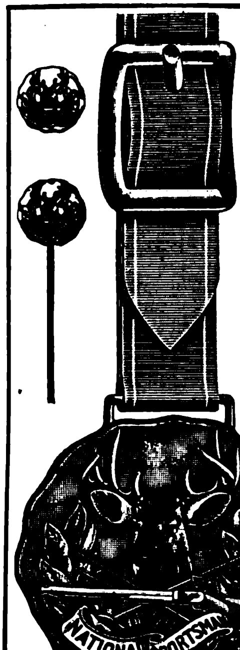

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MORGAN, ALFRED POWELL.
Wireless Telegraph Construction for Amateurs.—A manual of practical information for those who wish to build experimental wireless instruments which can be considered as something more than toys, but are still considerably less expensive than a high-grade commercial set. No attention has been paid to the history of the art, the space, instead, being devoted to short but complete explanations of the uses of the various instruments, as well as the structural details. 1910... 1.50

MORGAN, ALFRED P.
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PIERCE, GEO. W., Asst. Professor of Physics in Harvard University.
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ROBINSON, Lieut. Com. S. S.
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1913

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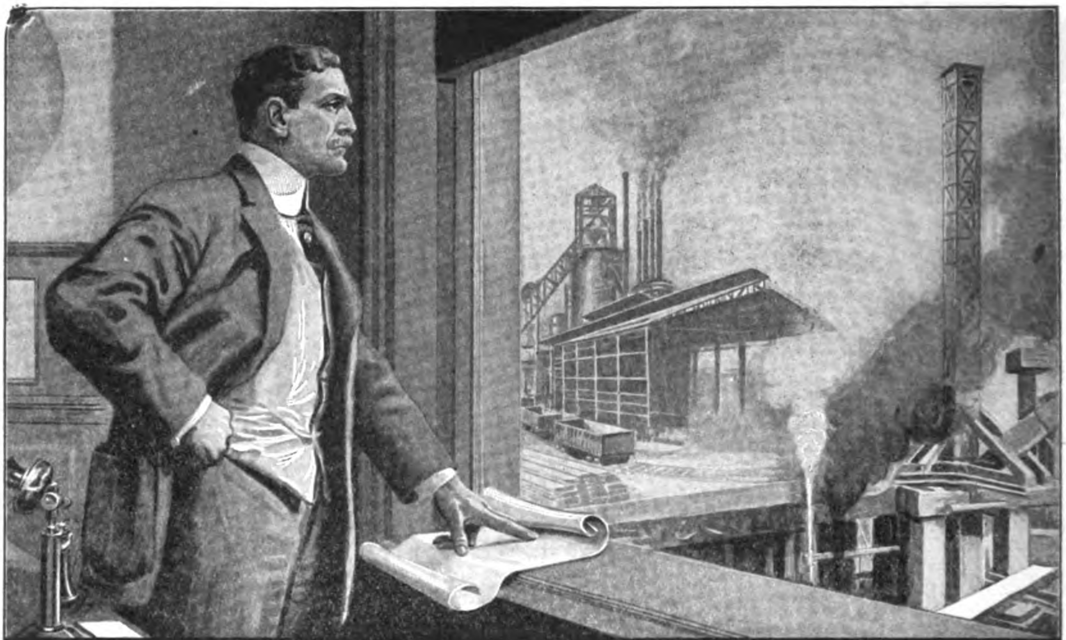


ELECTRICIAN & MECHANIC

VOLUME XXVI | MAY, 1913 | NUMBER 5

A PRACTICAL SECTION-LINER

Prize Article

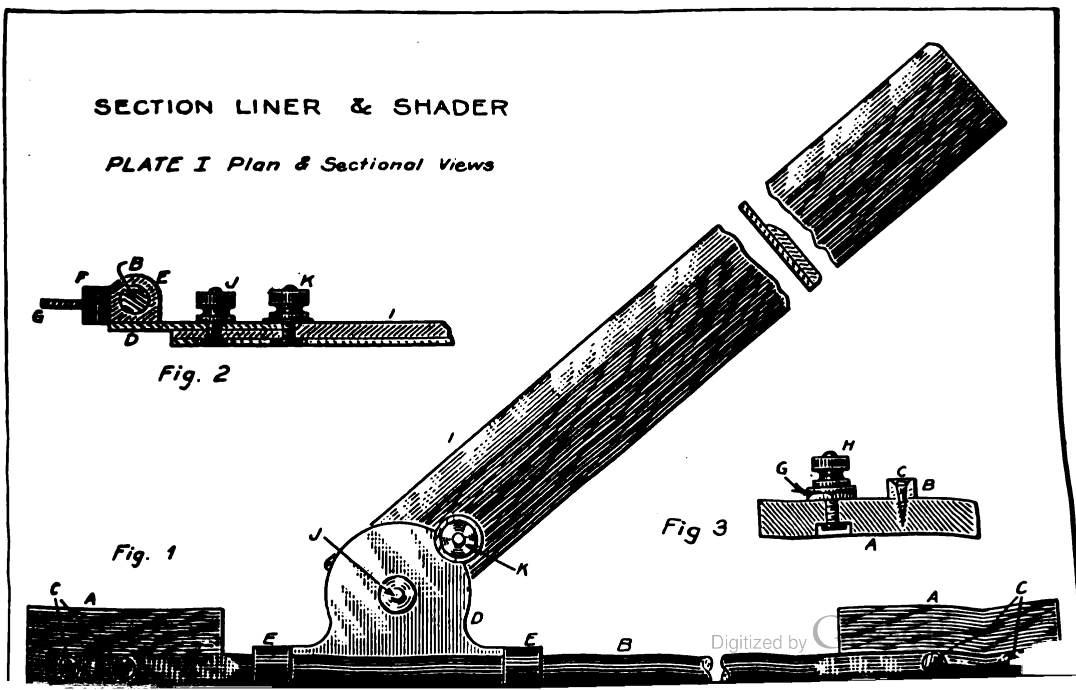
P. MERTZ

The designs of most section-liners are such that they cannot be constructed and made to work satisfactorily, unless the machining of the parts is done by one quite expert with tools. There are also some that are very simple and easily made, but their use generally gives unsatisfactory results, mostly due to the great liability of slipping while in use.

A type of section-liner eliminating most of the above faults was designed and constructed by the writer, and is shown in the accompanying illustrations.

In Plate I is shown the assembled instrument: Fig. 1, plan view; Fig. 2, cross-sectional view through the runner; and Fig. 3, cross-sectional view through one of the bases. Plate II shows working drawings of each of the parts separately, while Plate III shows samples of the work that can be done with the section-liner.

The bases *A* can be made of almost



any sort of wood, hardwood preferably. The rod *B* carrying the runner can be made of brass, iron or steel. As can be seen, it is flattened at both ends, so that it can be more easily fastened to the bases *A* with screws *C*.

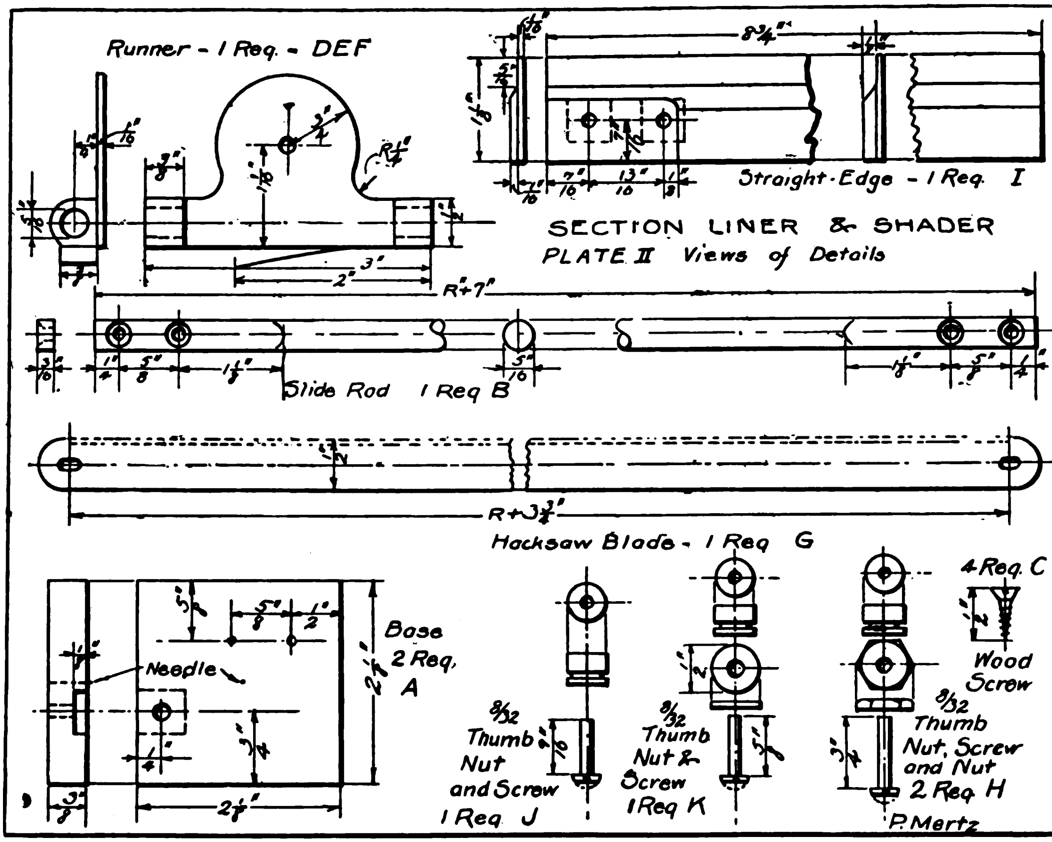
In Plate II, in the dimensions referring to the length of the rod, the letter *R* stands for the range of the section-liner. This is, in other words, the distance any part of the runner has moved when it has gone from the extreme left to the extreme right as far as it can go. On the writer's instrument, being primarily constructed for shading (the use of the device for this purpose will be explained further), the range is only 5 in. However, a more practical range would be 8 in., or more, especially if great areas are to be covered with cross-hatching. To return to the rod, it should be as straight as it possibly can be gotten, or trouble may later be encountered in using the section-liner. The runner *DE* is cut from a piece of heavy (1/16, in.) sheet brass, iron or steel. It will be found easier to cut it with a hack-saw and smooth down the edges with a file than to use shears. The runner is supported on the rod *B* by means of the blocks *E*. These are preferably made of brass filed and drilled to shape. In the writer's instrument the rod *B* and the blocks *E* were taken from the discarded part of a typewriter; thus *E* slides smoothly over the rod, without any jarring. These blocks are neatly soldered to *D*; soldering being used because it is a much simpler way than to fasten them together with screws, for which holes must be drilled and tapped.

However, the escapement is the part of this section-liner giving it its great simplicity and practicability. It consists of a piece of alarm-clock spring *F* soldered to the right-hand block *E*, as shown in Figs. 1 and 2. This piece of clock spring bears upon the toothed side of a hack-saw *G*, the teeth of the hack-saw being turned to the right. This hack-saw *G* is fastened to the bases *A* by means of the bolts and thumb-nuts *H*. The latter can be taken from the binding-posts of old batteries. The heads of the screws are, of course, sunk in, so as not to injure the surface of the paper upon which they rest. The writer has found the use of a hack-saw very satisfactory, as in general the teeth are accurately spaced on them. For general work one with 20 teeth to the inch is used, although if one with 30 can be had its use is recommended. Another hack-saw with 16 teeth to the inch should, if possible, be added to the equipment. This is used for drawing scales, as will be explained further on.

The usual holes in the hack-saw are lengthened with a file, as can be seen in Plate II, *G*. This feature permits of moving the part up and down, although it is not absolutely necessary, and very good work may be done without it.

The straight-edge is another very important part of a section-liner. Most section-liners have a wooden one, while some have it all celluloid (or some such transparent material). As can be seen from the illustrations, the form employed by the writer consists of a celluloid straight-edge *I*, over which is glued a piece of wood reinforcing. The celluloid permits of seeing the work immediately below the line being drawn; an advantage always appreciated in mechanical drawing, but especially when cross-hatching is being done. At first a solid celluloid straight-edge was used, but this did not prove satisfactory, owing to the fact that it bent sidewise, and it was difficult work to rule straight lines. However, by gluing a piece of wood over the celluloid, leaving a margin of about 5/16 in., a very good straight-edge is had. Perhaps a better one might be had by purchasing a maple celluloid-lined one, but these are quite expensive.

The method of clamping the straight-edge to the runner *D* is unique in that no difficult semi-circular slot has to be cut in the latter, although the joint is just as rigid. As shown in Figs. 1 and 2, Plate I, the clamping is done by means of two battery thumb-nuts *J* and *K* with screws. The screw for the former *J* passes through a hole in *I* and another in *D*. It is made from a round-head machine screw of the right size. The head of the screw has been filed down then so that it does not mar the paper underneath. A hole is cut in the celluloid, as can be seen, so that what remains of the head is sunk below the surface of the straight-edge. A battery thumb-nut is screwed over this screw. The other clamping screw *K* is practically the same as *J*, except that it clamps *D* under a washer. It will be



seen from the drawing that the wood *I* under *D* has been filed to admit the latter. Thus the washer under *K* lies flat. If desired, the straight-edge *I* need not be filed, but then a small piece of wood or metal must be placed under part of the washer, to make it lie flat; otherwise it will not satisfactorily clamp *I* to *D*.

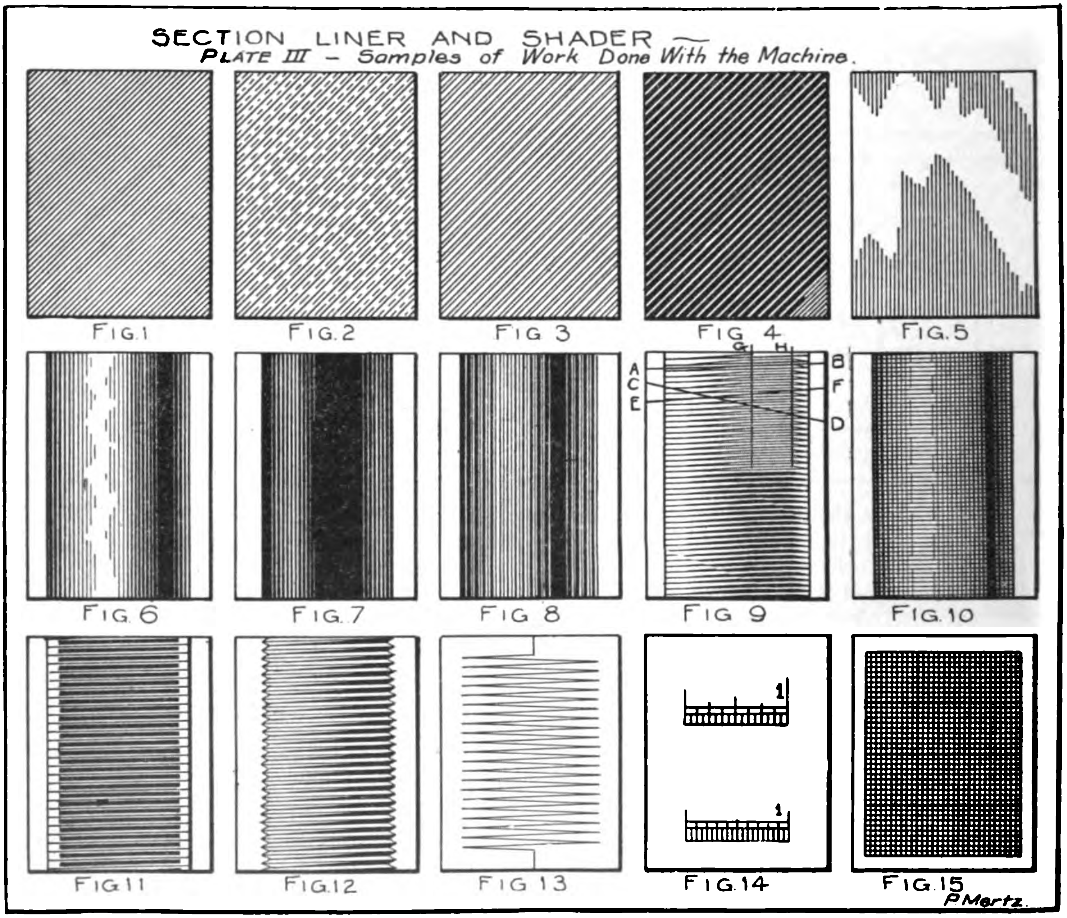
A rather fine needle should then be driven through each of the bases *A*, projecting about 1/16 in. from the under surfaces of these. The projecting top part of the needle is then broken off flush with the top of the base.

The section-liner is now complete after the wood parts are finished with stain and wax. A little oil put on the rod *B* about once a month will help a good deal towards the smooth working of the instrument.

The next thing after having constructed a section-liner is to be able to use it properly. For ordinary cross-hatching, the 20 teeth to the inch hack-saw is used, and the straight-edge inclined at an angle of about 45 degrees to the bar *B*. With this Figs. 1 and 2, Plate III, can be drawn without explanation, save that Fig. 2 looks better when the lines are somewhat closer together than in Fig. 1. Sectioning such as is shown in Fig. 3 can be done by loosening the bolts *H H*, slipping the hack-saw *G* a little to the right (this is possible only if the holes in the latter were filed oval, as mentioned before) and drawing only alternate lines. Then *G* is slipped to the left, and the remaining lines filled in. Cross-sections of insulating material, as shown in Fig. 4, can be done by first cross-hatching, as in the lower right-hand corner (having the lines somewhat closer together than in Fig. 1), and then filling in the alternate white spaces.

Metal surfaces, such as shown in Fig. 5, are shaded in the same way as Fig. 1, except that the shade-lines are parallel to one of the edges, and do not cover the whole surface. The shading of curved metal surfaces is shown in Fig. 6. This is self-explanatory, except that it might

be mentioned that the lines are all the same distance apart and vary only in thickness. This gives a much better effect than when the shade-lines are nearly equal in thickness, and the curved effect found by changing the distance between them. The use of a section-liner also renders the process much easier, and can well be adopted by the draftsman who has much trouble in giving curved effects to rods. Curved hard rubber or glossy black surfaces are shaded as shown in Fig. 7. It differs from Fig. 6 in that the lines comprising the shading are of such thickness that a good part of the surface is entirely black. Also the reflected light on the right is a little more to the left than in Fig. 6. It is understood that no lines are necessary to be drawn that the lines are slightly heavier and fine lines are inserted between the regular shade lines. When the milling is too fine to be conveniently drawn it is usually simply shaded, as in Fig. 6.



Side views of coils in which the wire is heavy enough to be conveniently drawn can be shaded in the manner shown in Fig. 9. After the wire has been represented, unshaded, in slightly finer lines than otherwise, two pencil lines *G* and *H* are drawn. Then, having the straight-edge in the general direction *AB* (parallel to the wire), lines extending from *G* to *H* are inserted between the wire-lines. The straight-edge is then swung to the direction *EF* (the whole section-liner should be swung so as not to alter the angle between the straight-edge and the

shown. The spaces which have not already been filled by the ink (see upper part of illustration) are filled in with the pen as can be seen in the lower part.

When the wire is too fine for doing the above, the shading is simply put on as shown in Fig. 10, that is, the same shading as in Fig. 6 (except that the lines are somewhat finer).

Screws can be very quickly done, as shown in Fig. 11, which needs no explanation beyond that, to save time, the light lines are drawn first; the heavy ones are inserted after the first are dry. When the screws have a heavy enough thread, they can be represented as shown in Fig. 12.

With a section-liner, symbols representing helices or coils used in wireless telegraph diagrams can be quickly and neatly executed (Fig. 13).

Earlier in this article the use of a section-liner for drawing scales was mentioned; scales so drawn are illustrated in Fig. 14. The upper one is the common scale of inches, and in drawing it the 16-teeth-to-the-inch hack-saw blade must be used on the instrument. The decimal scale is shown in the lower part of the figure, and the 20-teeth-to-the-inch hack-saw blade is used for this. In drawing these scales it is necessary that the straight-edge of the section-liner be at right angles to the slide-rod, or they will not be found to be accurate.

A good kind of cross-section paper can be easily produced with this section-liner, a sample of which is shown in Fig. 15. This is especially useful when a regular piece of cross-section paper is not at hand. There are many other uses to which this instrument may be put which will easily suggest themselves, and are too numerous to mention here.

MECHANICAL BILL COUNTER FOR U.S. TREASURY

Money counting is an art. Anyone can count a small sum of money slowly. To count a large sum of money quickly requires not only muscular skill of a high order, but strict attention. It is wearisome, nerve-racking. The monotony of it makes the human counter liable to error.

So a mechanical automatic money counter is a machine greatly needed, not only in the Treasury of the United States and its sub-treasuries, but in banks, counting-houses and other establishments where large sums of money must be totaled constantly.

Not until John P. Buckley invented his money-counting machine, however, did the Treasury officials believe that mechanism could take the place of the human brain. But the single machine of its kind in the world now counting laundered money in the basement of the Treasury at Washington is the first of a larger order, and it is expected, if the twelve machines now being made for the Treasury prove the possibilities indicated by the present machine, to equip the Treasury with large numbers of them, as well as the sub-treasuries.

Mr. Buckley's machine cannot count without a bill in the machine. The attendant sits before a low table on which is a small and compact mechanism. In front of her are several small, rapidly revolving rolls of a metal, on top of which are rapidly revolving wheels of brass. These wheels and rolls are in contact, and through them runs a small (half ampere) electric current. When a bill is fed in between the brass wheels and the rolls, the circuit is broken. The current has been actuating an electric magnet. The instant the magnet ceases to act, springs raise two flap doors to the compartment toward which the rolls and wheels are feeding the money. The bill slips out of the rolls and rests on these little flap doors. The act of raising these doors by the springs has actuated a mechanical counter. The instant the bill is ejected by the rolls, the electrical contact is re-made, the magnets pull down the doors, and the bill drops flat into the rack below.

When ninety-nine bills have fallen into the rack below, the little doors fly up as before for the hundredth bill, and count it, as before, as it passes through the rolls. But the little doors do not drop down again, a mechanical trip holding them in place. This is the signal for the operator to put a piece of blotting-paper or other separator on top of the hundredth bill. She then presses a button and the doors drop, carrying the hundredth bill and its separator into the magazine below.

A UNIQUE ALTERNATING-CURRENT NETWORK PROTECTOR

FRANK C. PERKINS

The accompanying illustrations, Figs. 1 and 2, show the design and construction of a metropolitan alternating-current network protector of the three-wire 12½ k.w. type. The photograph, Fig. 1, shows complete device ready for installation, while Fig. 2 shows coil and fuse block removed from case, and drawings Figs. 3 and 4, the electrical connections of this novel equipment.

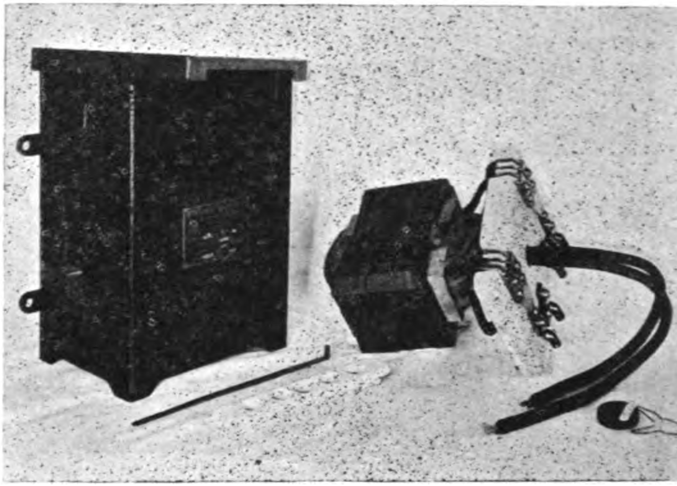


Fig. 2

Continuity of service in the distribution of alternating current for light and power is of great importance. It is the custom to generate at relatively high voltage, distributing by primary feeders and mains to points adjacent to where the power is required. At these points transformers are installed stepping down from the primary to secondary or low voltage suitable for the distributing network.

At first it was the custom to utilize small unit transformers, usually a transformer for a single or a small number of customers, and this practice is still followed in certain communities where customers are widely separated. In more or less congested territories it is found desirable to group the customers, extending the low voltage or secondary distributing mains over a considerable area, installing transformers of large units at convenient points and interconnecting them on both the primary and secondary sides.

This system has the advantage of improving the voltage regulation and takes advantage of the diversity factor in the customers' demand, so that the aggregate of the several large transformers thus connected can be less than the sum of the maximum demand of all the customers, whose several maxima never occur at the same time.

Where this network of system of connection is desirable, continuity of service is absolutely necessary, but in this method of multiple connection, in case of one transformer's burning out or otherwise causing a short-circuit on the system, the primary fuse of the defective transformer

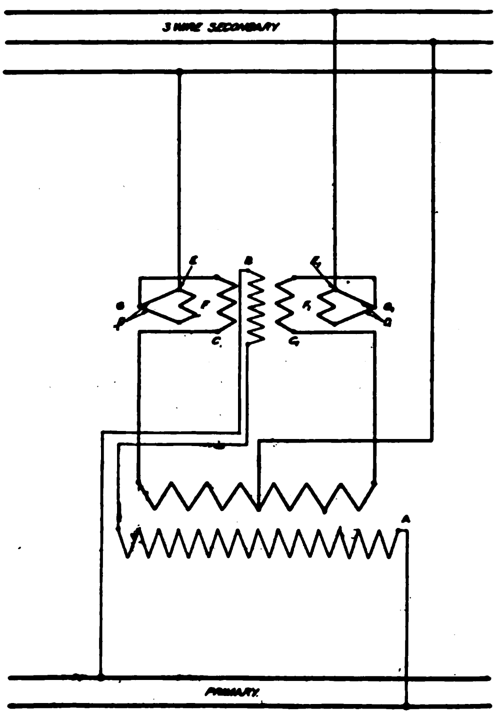


Fig. 3

the transformer nearest the short-circuit will take up most of the load, which will cause the fuse on this transformer to blow, in turn shifting its load to the next transformer.

In the same manner the fuses of the entire number are ruptured and the service supplied from this particular network of transformers interrupted, it being necessary before the service can be re-established to visit all the transforming points and replace the fuses, and this is a matter of delay and difficulty.

The alternating current network protector illustrated was designed instantaneously to disconnect a defective transformer, protecting the secondary network by preventing an overload on the remaining transformers and a consequent interruption of the service. It is entirely electrical—positive in action—free from moving parts—requires no attention or adjustment.

It is in reality a series or current transformer, having three windings: a primary, which is connected in series with the primary of the step-down or service transformer; a secondary winding, which is connected in series with the secondary of the transformer; and a third winding, which is of few turns and heavy wire so that the ratio of current that will flow in this coil when short-circuited and active is high as compared with current in the other coils.

The primary and secondary windings of the protective device are wound with the same ratio of turns as the primary and secondary of the step-down transformer with which it is to be used, and is connected in line with the step-down transformer, so that during normal operation the currents in the primary and secondary windings of the device oppose each other in direction, and as the ratio of the device and step-down transformer are equal the excitation in the two windings of the device are always equal, and being in opposition no current in the short-circuited coil.

In the electrical connections of the device for a three-wire network shown in Fig. 3, the commercial transformer is shown at *A*, one terminal of the primary being connected in series with a coil *B* of the current transformer.

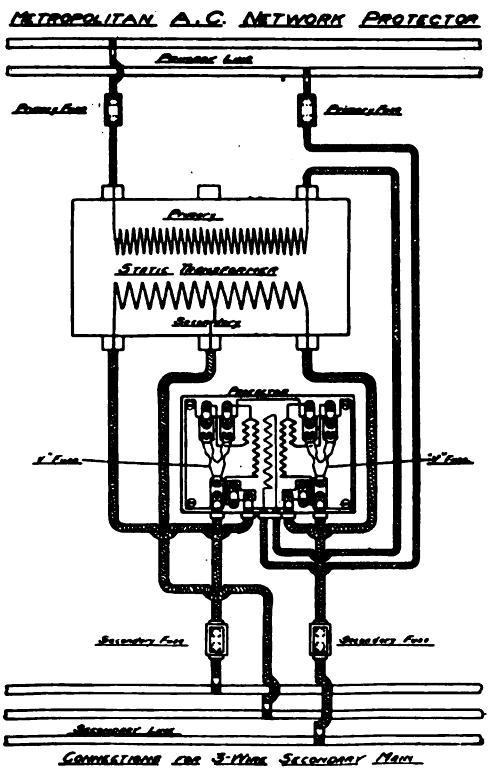


Fig. 4

The terminal of the secondary of the commercial transformer are connected each through its own coil C and C_1, on the current transformer. These latter coils connected to the middle point of the looped fuses D and D_1. One side of the fuses is connected from E and E_1, to the outer conductors of the three-wire network. The fuses D and D_1 act as a short-circuit connection on coils F and F_1.

The function of this combination is that under normal conditions the currents in the primary B and the secondary coil C and C_1 having the same ampere turns and connected in opposition will neutralize each other so that there will be no magnetic flux circulating in the core of the current transformers to energize the coils E and E_1.

This balance of conditions is maintained at all loads and is only upset by a reverse current flowing from the secondary network into the transformer as is occasioned by a short circuit in the latter. This condition immediately reverses the relative polarity of the coils C and C_1, thus energizing the core and causing a heavy short-circuit current to flow through the coils E and E_1, by way of their short-circuiting fuses D and D_1.

The heavy short circuit current through the fuse immediately ruptures, and then isolates, the main terminal at G and G_1. A supply of current sufficient to blow the V fuse is obtained with a reverse current in the secondary of about one-quarter full load current on the transformer, the defective transformer will thus be instantaneously cut out and disconnected from the line, allowing the remaining transformers connected to the network to continue their function taking up the load of the defective transformer without any interruption in the service whatever.

TRUING EMERY WHEELS

LYMAN ROBBINS

The emery grinder is an absolute necessity in every woodworking shop. But every emery-wheel should be kept in first-class condition, otherwise it will be a necessary evil. With the improved truing devices which have been invented, there is no excuse for a wheel's being out of condition for a single instant.

The hand truing tool is well known to most shop men, but the automatic truing device may be a novelty to other woodworkers. This new piece of machinery is entirely permanent upon the emery-wheel and requires only a turn of the wrist to bring it into operation. It is power-driven and travels forward a certain distance and cuts away every particle of emery from the wheel within that distance.

Once an automatic truing device has been tried in the shop, you will have no further use for the hand tools, except in shaping up special emery-wheels and grinding intricate cutters.

Some shops do not have even a diamond point for truing emery-wheels. And I have seen a bundle of washers quently, never waiting until the surface is out of round. By thus truing, the wheel will always be ready to do its best work and the greatest possible quantity thereof.

Do not overlook the matter of light. Good work cannot be done with an emery-wheel which is placed in a dark corner and so located that the workman obtsructs what little light does get to the machine.

Put the emery grinder in front of a window if possible. If it must be in a dark place, see that a good lamp, electric if possible, is located where it will give light enough for the workman to see what he is doing.

While installing the emery grinder, do not forget to procure a machine with room for a half dozen wheels upon the spindle. Put on several grades of emery and into two of the wheel spaces place an oilstone and a leather buffing wheel. These two wheels will be found as great time savers as the emery wheels themselves.

As a result of the recent tests, government experts declare that the Arlington

RADIOTELEGRAPHY*

COMMENDATORE G. MARCONI, LL.D.,D.SC.

The practical application of electric waves to the purposes of wireless telegraphic transmission over long distances has continued to extend to a remarkable degree during the last few years, and many of the difficulties, which at the outset appeared almost insurmountable, have been gradually overcome, chiefly through the improved knowledge which we have obtained in regard to the subject generally and to the principles involved.

The experiments which I have been fortunate enough to be able to carry out, on a much larger scale than can be done in ordinary laboratories, have made possible the investigation of phenomena often novel and certainly unexpected.

Although we have—or believe we have—all the data necessary for the satisfactory production and reception of electric waves, we are yet far from possessing any very exact knowledge concerning the conditions governing the transmission of these waves through space, especially over what may be termed long distances. Although it is now perfectly easy to design, construct, and operate stations capable of satisfactory commercial working over distances up to 2,500 miles, no really clear explanation has yet been given of many absolutely authenticated facts concerning these waves. Some of these hitherto apparent anomalies I shall mention briefly in passing.

Why is it that when using short waves the distances covered at night are usually enormously greater than those traversed in the day-time, while, when using much longer waves the range of transmission by day and night is about equal and sometimes even greater by day?

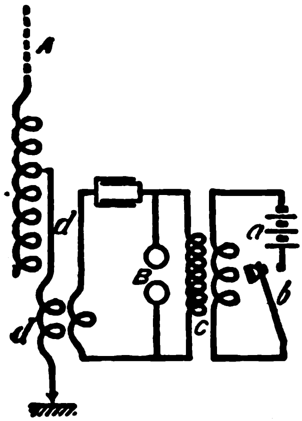


Fig. 3

What explanation has been given of the fact that the night distances obtainable in a north-southerly direction are so much greater than those which can be effected in an east-westerly one?

Why is it that mountains and land generally should greatly obstruct the propagation of short waves when sunlight is present and not during the hours of darkness?

The general principles on which practical radiotelegraphy is based are now so well known that I need only refer to them in the briefest possible manner.

Wireless telegraphy, which was made possible by the fields of research thrown open by the work of Faraday, Maxwell and Hertz, is operated by electric waves, which are created by alternating currents of very high frequency, induced in suitably placed elevated wires or capacity areas. These waves are received or picked up at a distant station on other elevated conductors tuned to the period of the waves, and the latter are revealed to our senses by means of appropriate detectors.

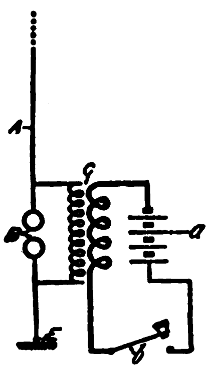


Fig. 1

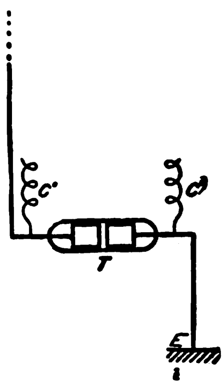


Fig. 2

My original system as used in 1896 consisted of the arrangement shown

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diagrammatically in Fig. 1, where an elevated or vertical wire was employed. This wire sometimes terminated in a capacity or was connected to earth through a spark gap.

By using an induction coil or other source of sufficiently high tension electricity sparks were made to jump across the gap; this gave rise to oscillations of high frequency in the elevated conductor and earth, with the result that energy in the form of electric waves was radiated through space.

At the receiving station, Fig. 2, these waves induced oscillatory currents in a conductor containing a detector, in the form of a coherer, which was usually placed between the elevated conductor and earth.

Although this arrangement was extraordinarily efficient in regard to the radiation of electrical energy, it had numerous drawbacks.

The electrical capacity of the system was very small, with the result that the small amount of energy in the aerial was thrown into space in an exceedingly short period of time. In other words, the energy, instead of giving rise to a train of waves, was all dissipated after only a few oscillations, and, consequently, anything approaching good tuning between the transmitter and receiver was found to be unobtainable in practice.

Many mechanical analogies could be quoted which show that in order to obtain syntony the operating energy must be supplied in the form of a sufficient number of small oscillations or impulses properly timed. Acoustics furnish us with numerous examples of this fact, such as the resonance produced by the well-known tuning fork experiment.

Other illustrations of this principle may be given; *e.g.*, if we have to set a heavy pendulum in motion by means of small thrusts or impulses, the latter must be timed to the period of the pendulum, as otherwise its oscillations would not acquire any appreciable amplitude.

In 1900 I first adopted the arrangement which is now in general use, and which consists, as shown in Fig. 3, of the inductive association of the elevated radiating wire with a condenser circuit which may be used to store up a considerable amount of electrical energy and impart it at a slow rate to the radiating wire.

As is now well known, the oscillations in a condenser circuit can be made to persist for what is electrically a long period of time, and it can be arranged, moreover, that by means of suitable aerials or antennae these oscillations are radiated into space in the form of a series of waves, which through their cumulative effect are eminently suitable for enabling good tuning and syntony to be obtained between the transmitter and receiver.

The circuits, consisting of the condenser circuit and the elevated aerial or radiating circuit, were more or less closely coupled to each other. By adjusting the inductance in the elevated conductor, and by the employment of the right value of capacity or inductance required

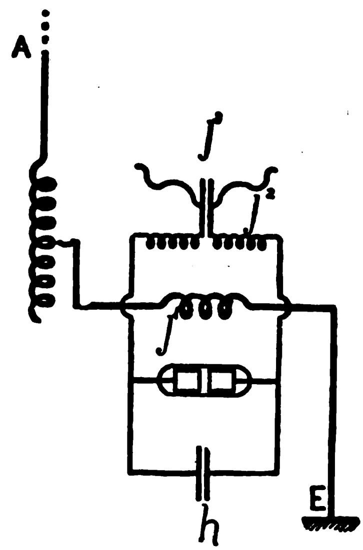


Fig. 4

in the condenser circuit, the two circuits were brought into electrical resonance, a condition which I first pointed out as being essential in order to obtain efficient radiation and good tuning.

The receiver, as shown in Fig. 4, also consists of an elevated conductor or aerial connected to earth or capacity through an oscillating transformer. The latter also contains the condenser and detector, the circuits being made to have approximately the same electrical time period as that of the transmitter circuits.

At the long distance station situated at Clifden, in Ireland, the arrangement which has given the best results is based substantially upon my syntonic system

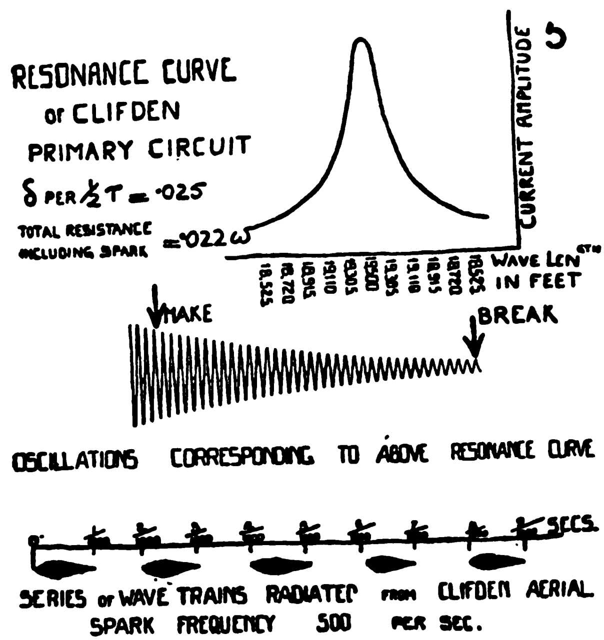


Fig. 5

of 1900, to which have been added numerous improvements.

An important innovation from a practical point of view was the adoption at Clifden and Glace Bay of air condensers, composed of insulated metallic plates suspended in air at ordinary pressure. In this manner we greatly reduce the loss of energy which would take place in consequence of dielectric hysteresis were a glass or solid dielectric employed. A very considerable economy in working also results from the absence of dielectric breakages, for, should the potential be so raised as to even produce a discharge from plate to plate across the condenser, this does not permanently affect the value of the dielectric, as air is self-healing and one of the few commodities which can be replaced at a minimum of cost.

Various arrangements have been tried and tested for obtaining continuous or very prolonged trains of waves, but it has been my experience that, when utilizing the best receivers at present available, it is neither economical nor efficient to attempt to make the waves too continuous. Much better results are obtained when groups of waves, Fig. 5, are emitted at regular intervals in such manner that their cumulative effect produces a clear musical note in the receiver, which is tuned not only to the periodicity of the electric waves transmitted, but also to their group frequency.

In this manner the receiver may be doubly tuned, with the result that a far greater selectivity can be obtained than by the employment of wave tuning alone.

In fact, it is quite easy to pick up simultaneously different messages transmitted on the same wave-length, but syntonized to different group frequencies.

As far as wave tuning goes, very good results—almost as good as are obtainable by means of continuous oscillation — can be achieved with groups of waves, the decrement of which is in each group 0.03 or 0.04, which means that about 30 or 40 useful oscillations are radiated before their amplitude has become too small to perceptibly affect the receiver.

The condenser circuit at Clifden has a decrement of from 0.015 to 0.03 for fairly long waves.

This persistency of the oscillations has been obtained by the employment of the system shown in Fig. 6, which I first described in a patent taken out in September, 1907. This method eliminates

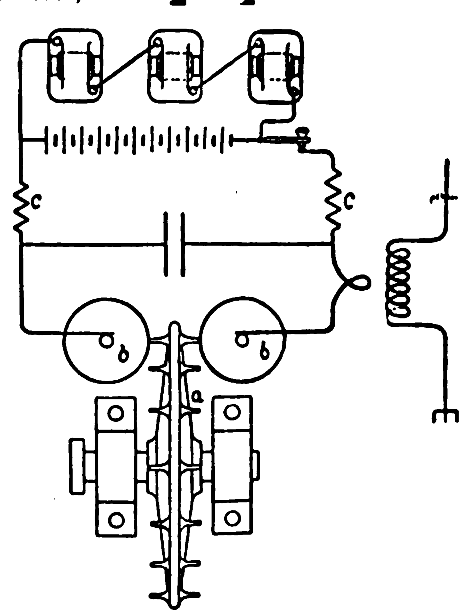


Fig. 6—Disc Discharger. Continuous Current

almost completely the spark gap and its consequent resistance, which, as is well known, is the principal cause of the damping or decay of the waves in the usual transmitting circuit.

The apparatus shown in Fig. 6 consists of a metal disc *a*, having copper studs firmly fixed at regular intervals in its periphery and placed transversely to its plane. This disc is caused to rotate very rapidly between two other discs *b*, by means of a rapidly revolving electric motor or steam turbine. These side discs are also made slowly to turn round in a plane at right angles to that of the middle disc. The connections are as illustrated in the figure. The studs are of such length as to just touch the side discs in passing, and thereby bridge the gap between the latter.

With the frequency employed at Clifden, namely, 45,000, when a potential of 15,000 volts is used on the condenser, the spark gap is practically closed during the time in which one complete oscillation

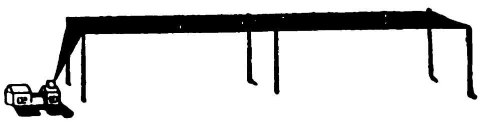


Fig. 7

only is taking place, when the peripherical speed of the disc is about 600 ft. a second. The result is that the primary circuit can continue oscillating without material loss by resistance in the spark gap. Of course the number of oscillations which can take place is governed by the breadth or thickness of the side discs, the primary circuit being abruptly opened as soon as the studs attached to the middle disc leave the side discs.

This sudden opening of the primary circuit tends to immediately quench any oscillations which may still persist in the condenser circuit; and this fact carries with it a further and not inconsiderable advantage, for if the coupling of the condenser circuit to the aerial is of a suitable value the energy of the primary will have practically all passed to the aerial circuit during the period of time in which the primary condenser circuit is closed by the stud filling the gap between the side discs; but after this the opening of the gap at the discs prevents the energy returning to the condenser circuit from the aerial, as would happen were the ordinary spark gap employed. In this manner the usual reaction which would take place between the aerial and the condenser circuit can be obviated, with the result that with this type of discharger and with a suitable degree of coupling the energy is radiated from the aerial in the form of a pure wave, the loss from the spark gap resistance being reduced to a minimum.

I am able to show a resonance curve taken at Clifden which was obtained from the oscillations in the primary alone, Fig. 5.

An interesting feature of the Clifden plant, especially from a practical and engineering point of view, is the regular employment of high-tension direct current for charging the condenser. Continuous current at a potential which is capable of being raised to 20,000 volts is obtained by means of special direct-current generators; these machines charge a storage battery consisting of 6,000 cells, all connected in series, and it may be pointed out that this battery is the largest of its kind in existence. The capacity of each cell is 40 ampere-hours. When employing the cells alone the working voltage is from 11,000 to 12,000 volts, and when both the direct-current generators and the battery are used together the potential may be raised to 15,000 volts through utilizing the gassing voltage of the storage cells.

For a considerable portion of the day the storage battery alone is employed, with a result that for 16 hours out of the 24 no running machinery need be used for operating the station, with the single exception of the small motor revolving the disc.

The potential to which the condenser is charged reaches 18,000 volts when that of the battery or generators is 12,000. This potential is obtained in consequence of the rise of potential at the condenser plates, brought about by the rush of current through the choking or inductance coils at each charge. These coils are placed between the battery or generator and the condenser *c*, Fig. 6.

No practical difficulty has been encountered either at Clifden or Glace Bay in regard to the insulation and maintenance of these high-tension storage batteries. Satisfactory insulation has been

obtained by dividing the battery into small sets of cells placed on separate stands. These stands are suspended on insulators attached to girders fixed in the ceiling of the battery room. A system of switches, which can all be operated electrically and simultaneously, divides the battery into sections, the potential of each section being low enough to enable the cells to be handled without inconvenience or risk.

The arrangement of aerial adopted at Clifden and Glace Bay is shown in Fig. 7. This system, which is based on the result of tests which I first described before the Royal Society in June, 1906,* not only makes it possible efficiently to radiate and receive waves of any desired length, but it also tends to confine the main portion of the radiation to any desired direction. The limitation of transmission to one direction is not very sharply defined, but nevertheless the results obtained are exceedingly useful for practical working.

In a similar manner, by means of these horizontal wires, it is possible to define the bearing or direction of a sending station, and also limit the receptivity of the receiver to waves arriving from a given direction.

The commercial working of radiotelegraphy and the widespread application of the system on shore and afloat in nearly all parts of the world has greatly facilitated the marshaling of facts and the observation of effects. Many of these, as I have already stated, still await a satisfactory explanation.

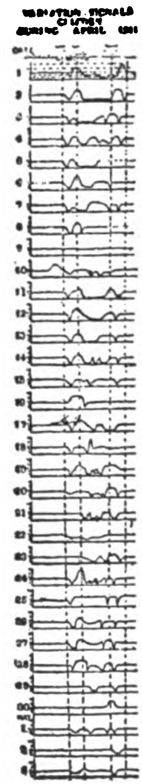


Fig. 9

daylight on the propagation of electric waves over great distances.

The generally accepted hypothesis of the cause of this absorption of electric waves in sunlight is founded on the belief that the absorption is due to the ionization of the gaseous molecules of the air

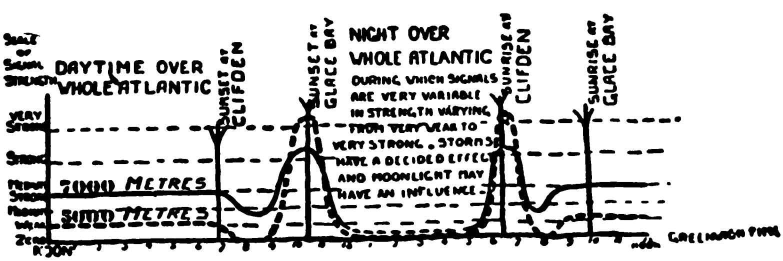


Fig. 8

A curious result which I first noticed over nine years ago in long-distance tests carried out on the steamship *Philadelphia*, and which still remains an important

affected by the ultra-violet light, and as the ultra-violet rays which emanate from the sun are largely absorbed in the upper atmosphere of the earth, it is probable

more ions or electrons than that which is in darkness, and therefore, as Sir J. J. Thomson has shown,* this illuminated or ionized air will absorb some of the energy of the electric waves.

The wave-length of the oscillations employed has much to do with this interesting phenomenon, long waves being subject to the effect of daylight to a very much lesser degree than are short waves.

Although certain physicists thought some years ago that the daylight effect should be more marked on long waves than on short, the reverse has been my experience; indeed, in some transatlantic experiments, in which waves about 8,000 meters long were used, the energy received by day at the distant receiving station was usually greater than that obtained at night.

Recent observation, however, reveals the interesting fact that the effects vary greatly with the direction in which transmission is taking place, the results obtained when transmitting in a northerly and southerly direction being often altogether different from those observed in the easterly and westerly one.

Research in regard to the changes in the strength of the received radiations which are employed for telegraphy across the Atlantic has been recently greatly facilitated by the use of sensitive galvanometers, by means of which the strength of the received signals can be measured with a fair degree of accuracy.

In regard to moderate power stations such as are employed on ships, and which, in compliance with the international convention, use wave-lengths of 300 and 600 meters, the distance over which communication can be effected during daytime is generally about the same, whatever the bearing of the ships to each other or to the land stations—while at night interesting and apparently curious results are obtained. Ships over 1,000 miles away, off the south of Spain or round the coast of Italy, can almost always communicate during the hours of darkness with the post-office stations situated on the coasts of England and Ireland, while the same ships, when at a similar distance on the Atlantic to the westward hardly ever communicate with these shore stations unless by means of specially powerful instruments.

It is also to be noticed that in order to reach ships in the Mediterranean the electric waves have to pass over a large portion of Europe, and, in many cases, over the Alps. Such long stretches of land, especially when including very high mountains, constitute, as is well known, an insurmountable barrier to the propagation of short waves during the daytime. Although no such obstacles lie between the English and Irish stations and ships in the North Atlantic en route for North America, a night transmission of 1,000 miles is there of exceptionally rare occurrence. The same effects generally are noticeable when ships are communicating with stations situated on the Atlantic coast of America.

Although high power stations are now used for communicating across the Atlantic Ocean, and messages can be sent by day as well as by night, there still exist periods of fairly regular daily occurrence during which the strength of the received signals is at a minimum. Thus in the morning and the evening, when, in consequence of the difference in longitude, daylight or darkness extends only part of the way across the ocean, the received signals are at their weakest. It would almost appear as if electric waves, in passing from dark space to illuminated space and *vice versa*, were reflected and refracted in such a manner as to be diverted from the normal path.

Later results, however, seem to indicate that it is unlikely that this difficulty would be experienced in telegraphing over equal distances north and south on about the same meridian, as, in this case, the passage from daylight to darkness would occur more rapidly over the whole distance between the two stations.

I have here some diagrams which have been carefully prepared by Mr. H. J. Round. These show the average daily variation of the signals received at Clifden from Glace Bay.

The curves traced on the diagram, Fig. 8, show the usual variation in the strength of these transatlantic signals on

The strength of the received waves remains as a rule steady during daytime.

Shortly after sunset at Clifden they become gradually weaker, and about two hours later they are at their weakest. They then begin to strengthen again, and reach a very high maximum at about the time of sunset at Glace Bay.

They then gradually return to about normal strength, but through the night they are very variable. Shortly before sunrise at Clifden the signals commence to strengthen steadily, and reach another high maximum shortly after sunrise at Clifden. The received energy then steadily decreases again until it reaches a very marked minimum, a short time before sunrise at Glace Bay. After that the signals gradually come back to normal day strength.

It can be noticed that, although the shorter wave gives on the average weaker signals, its maximum and minimum variations of strength very sensibly exceed that of the longer waves.

Fig. 9 shows the variations at Clifden during periods of 24 hours, commencing at 12 noon throughout the month of April, 1911, the vertical dotted lines representing sunset and sunrise at Glace Bay and Clifden.

Fig. 10 shows the curve for the first day of each month for one year, from May, 1910, to April, 1911.

I carried out a series of tests over longer distances than had ever been previously attempted, in September and October of last year, between the stations of Clifden and Glace Bay, and a receiving station placed on the Italian Steamship, *Principessa Mafalda*, in the course of a voyage from Italy to Argentina (Fig. 10*a*).

During these tests the receiving wire was supported by means of a kite, as was done in my early transaltantic tests of 1901, the height of the kite varying from about 1,000 to 3,000 ft. Signals and messages were obtained without difficulty, by day as well as by night, up to a distance of 4,000 statute miles from Clifden.

Beyond that distance reception could only be carried out during night-time. At Buenos Ayres, over 6,000 miles from Clifden, the night signals from both Clifden and Glace Bay were generally good, but their strength suffered some variations.

It is rather remarkable that the radiations from Clifden should have been detected at Buenos Ayres so clearly at night-time and not at all during the day, while in Canada the signals coming from Clifden (2,400 miles distant) are no stronger during the night than they are by day.

Further tests have been carried out recently for the Italian Government between a station situated at Massaua in East Africa and Coltano in Italy. Considerable interest attached to these experiments, in view of the fact that the

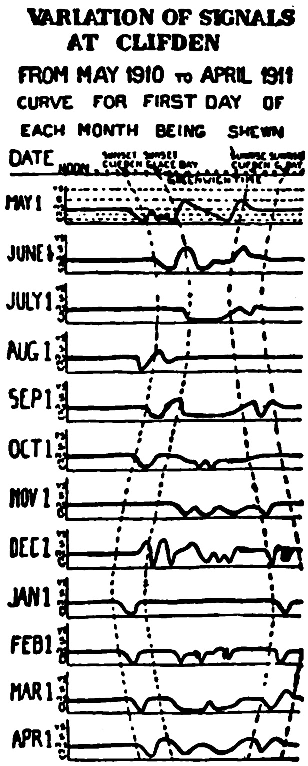


Fig. 10

line connecting the two stations passes over exceedingly dry country and across vast stretches of desert, including parts of Abyssinia, the Soudan, and the Libyan Desert. The distance between the two stations is about 2,600 miles.

The wave-length of the sending station in Africa was too small to allow of transmission being effected during daytime, but the results obtained during the hours of darkness were exceedingly good, the

received signals being quite steady and readable.

The improvements introduced at Clifden and Glace Bay have had the result of greatly minimizing the interference to which wireless transmission over long distances was particularly exposed in the early days.

The signals arriving at Clifden from Canada are as a rule easily read through any ordinary electrical atmospheric disturbance. This strengthening of the received signals has moreover made possible the use of recording instruments, which will not only give a fixed record of the received messages, but are also capable of being operated at a much higher rate of speed than could ever be obtained by means of an operator reading by sound or sight. The record of the signals is obtained by means of photography in the following manner: A sensitive Einthoven string galvanometer is connected to the magnetic detector or valve receiver, and the deflections of its filament caused by the incoming signals are projected and photographically fixed on a sensitive strip, which is moved along at a suitable speed. On some of these records, which I am able to show, it is interesting to note the characteristic marks and signs produced among the signals by natural electric waves or other electrical disturbances of the atmosphere, which, on account of their doubtful origin, have been called "X's."

Although the mathematical theory of electric wave propagation through space was worked out by Clerk Maxwell more than 50 years ago, and notwithstanding all the experimental evidence obtained in laboratories concerning the nature of these waves, yet so far we understand but incompletely the true fundamental principles concerning the manner of propagation of the waves on which wireless telegraph transmission is based. For example, in the early days of wireless telegraphy it was generally believed that the curvature of the earth would constitute an insurmountable obstacle to the transmission of electric waves between widely-separated points. For

earth connection, especially in regard to the transmission of oscillations over long distances.

Physicists seemed to consider for a long time that wireless telegraphy was solely dependent on the effects of free Hertzian radiation through space, and it was years before the probable effect of the conductivity of the earth was considered and discussed.

Lord Rayleigh, in referring to transatlantic radiotelegraphy, stated in a paper read before the Royal Society in May, 1903, that the results which I had obtained in signalling across the Atlantic suggested "a more decided bending or diffraction of the waves round the protuberant earth than had been expected," and further said that it imparted a great interest to the theoretical problem.* Prof. Fleming, in his book on electric wave telegraphy, gives diagrams showing what may be taken to be a diagrammatic representation of the detachment of semi-loops of electric strain from a simple vertical wire, Fig. 11.

As will be seen, these waves do not propagate in the same manner as does free radiation from a classical Hertzian oscillator, but instead glide along the surface of the earth.

Prof. Zenneck† has carefully examined the effect of earthed receiving and transmitting aerials, and has endeavored to show mathematically that when the lines of electrical force, constituting a wave front, pass along a surface of low specific inductive capacity—such as the earth—they become inclined forward, their lower ends being retarded by the resistance of the conductor, to which they are attached. It therefore would seem that wireless telegraphy as at present practiced is, to some extent at least, dependent on the conductivity of the earth, and that the difference in operation across long distances of sea compared to over land is sufficiently explained by the fact that sea water is a much better conductor than is land.

The importance or utility of the earth connection has been sometimes questioned, but in my opinion no practical

manner connected to earth. By connection to earth I do not necessarily mean an ordinary metallic connection as used for wire telegraphs. The earth wire may have a condenser in series with it, or it may be connected to what is really equivalent, a capacity area placed close to the surface of the ground. It is now perfectly well known that a condenser, if large enough, does not prevent the passage of high-frequency oscillations, and therefore in this case, when a so-called balancing capacity is used, the antenna is for all practical purposes connected to earth.

I am also of opinion that there is absolutely no foundation in the statement which has recently been repeated to the effect that an earth connection is detrimental to good tuning, provided of course that the earth is good.

Certainly, in consequence of its resistance, what electricians call a bad earth

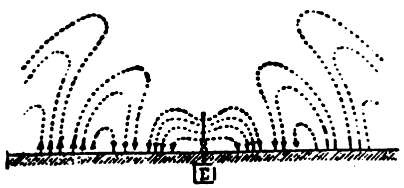


Fig. 11

will damp out the oscillations, and in that way make tuning difficult; but no such effect is noticed when employing an efficient earth connection.

In conclusion, I believe that I am not any too bold when I say that wireless telegraphy is tending to revolutionize our means of communication from place to place on the earth's surface. For example, commercial messages containing a total of 812,200 words were sent and received between Clifden and Glace Bay from May 1, 1910, to the end of April, 1911; wireless telegraphy has already furnished means of communication between ships and the shore where communication was before practically impossible. The fact that a system of imperial wireless telegraphy is to be discussed by the imperial conference, now holding its meetings in London, shows the supremely important position which radiotelegraphy over long distances has assumed in the short space of one decade. Its importance from a commercial, naval, and military point of view has increased very greatly during the last few years as a consequence of the innumerable stations which have been erected, or are now in course of construction, on various coasts, in inland regions, and on board ships in all parts of the world. Notwithstanding this multiplicity of stations and their almost constant operation, I can say from practical experience that mutual interference between properly equipped and efficiently tuned instruments has so far been almost entirely absent. Some interference does without doubt take place between ships, in consequence of the fact that the two wave-lengths adopted in accordance with the rules laid down by the international convention are not sufficient for the proper handling of the very large amount of messages transmitted from the ever increasing number of ships fitted with wireless telegraphy. A considerable advantage would be obtained by the utilization of a third and longer wave to be employed exclusively for communication over long distances.

In regard to the high-power transatlantic stations, the facility with which interference has been prevented has to some extent exceeded my expectations. At the receiving station situated at a distance of only 8 miles from the powerful sender at Clifden, during a recent demonstration arranged for the Admiralty, messages could be received from Glace Bay without any interference from Clifden when this latter station was transmitting at full power on a wave-length differing only 25 per cent. from the wave radiated from Glace Bay, the ratio between the maximum recorded range of Clifden and 8 miles being in the proportion of 750 to 1.

Arrangements are being made to permanently send and receive simultaneously at these stations, which, when completed, will constitute in effect the duplexing of radiotelegraphic communication between Ireland and Canada.

The result which I have last referred to also goes to show that it would be practicable to operate at one time, on slightly different wave-lengths, a great number of long-distance stations situated in England and Ireland without danger of mutual interference.

The extended use of wireless telegraphy is principally dependent on the ease with which a number of stations can be effi-

ciently worked in the vicinity of each other.

Considering that the wave-lengths at present in use range from 200 to 23,000 ft., and moreover that wave group tuning and directive systems are now available, it is not difficult to foresee that this comparatively new method of communication is destined to fill a position of the greatest importance in facilitating communication throughout the world.

Apart from long-distance work, the practical value of wireless telegraphy may perhaps be divided into two parts: (1) when used for transmission over sea and (2) when used over land.

Many countries, including Italy, Canada and Spain, have already supplemented their ordinary telegraph systems by wireless telegraphy installations, but some time must pass before this method of communication will be very largely used for inland purposes in Europe generally, owing to the efficient network of land lines already existing which render further means of communication unnecessary; and therefore it is probable that, at any rate for the present, the main use of radiotelegraphy will be confined to extra-European countries, in some of which climatic conditions and other causes absolutely prohibit the efficient maintenance of land-line telegraphy. A proof of this has been afforded by the success which has attended the working of the stations recently erected in Brazil on the upper Amazon.

By the majority of people the most marvelous side of wireless telegraphy is perhaps considered to be its use at sea. Up to the time of its introduction, ships at any appreciable distance from land had no means of getting in touch with the shore throughout the whole duration of their voyage. But those who now make long sea journeys are no longer cut off from the rest of the world; business men can continue to correspond at reasonable rates with their offices in America or Europe; ordinary social messages can be exchanged between passengers and their friends on shore; a daily newspaper is published on board most of the principal liners, giving the chief news of the day. Wireless telegraphy has on more than one occasion is the arrest, which took place recently through its agency, of a notorious criminal when about to land in Canada.

The chief benefit, however, of radiotelegraphy lies in the facility which it affords to ships in distress of communicating their plight to neighboring vessels or coast stations; that it is now considered indispensable for this reason is shown by the fact that several governments have passed a law making a wireless-telegraph installation a compulsory part of the equipment of all passenger boats entering their ports.

Deaf and Dumb Converse

DR. LEONARD KEENE HIRSHBERG

A curious electrical device—called a "deaf mute's telephone"—has recently been designed to enable those who can neither speak nor hear to communicate rapidly, not only with each other, but also with persons more fortunate than themselves, but who are not conversant with the "finger sign" language. The 'phone comprises essentially an electrical keyboard, somewhat like that of a typewriter, and is also fitted with a "universal system" arrangement of letters. This keyboard is connected by wire with an electric signal board, which comprises the "talking machine." It consists of thirty-six incandescent light globes, each with a large letter of the alphabet or one of the nine numerals painted on the end of the bulb. The person who wishes to "converse" presses the keys, spelling out the words as on a typewriter, the person at the other end reads the letters as they flash on the lamps. The keys descend on points of contact in the same manner as do the printing typewriter telegraph machines. This does away with any false or lost motion, and insures perfect contacts. The keyboard, however, can be operated as quickly by an expert as an ordinary typewriter, and the letters and numerals can be read as quickly as they can be flashed out. Thus persons familiar with an ordinary universal keyboard could readily operate this device, and with a little practice could become expert at it. The device is also useful for silent signalling and conversation between two people of normal faculties who desire to keep their conversation

MANUFACTURE OF AUTOMOBILE ENGINE CYLINDERS

GEO. F. WORTS

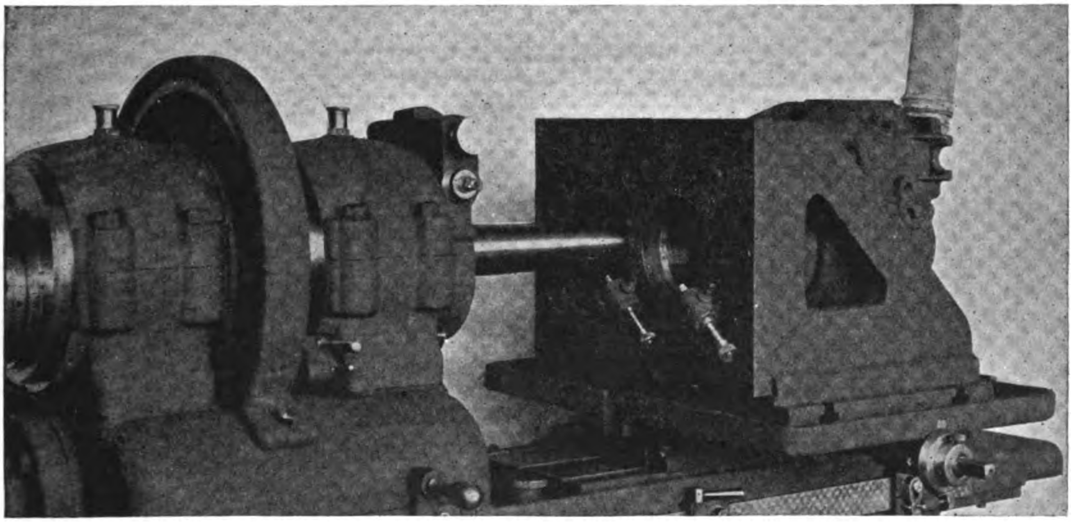
The cylinders are cast in sand molds singly, although some makes embody the "en bloc" type of motor in which all cylinders are cast together forming one block. From the foundry, the rough castings are removed to a cleaning room where all vestiges of sand are carefully removed and the rough places, called "fins," resulting from imperfections in the mold, are ground off by an abrasive wheel of coarse grit attached to a small electric "hand motor." The cylinder is then bored out, reamed and otherwise machined until the hole has approached to within seven thousandths to eleven thousandths of an inch of size, leaving on an average of nine thousandths of an inch to be removed by grinding. Heald Cylinder Grinding Machines are largely used which employ the high speed abrasive wheels and put the finishing touch to the "heart" of the motor car, as it can truthfully be called.

A battery of five of these machines is in constant operation at the factory visited by the writer and produce on an average of 250 cylinders a day.

A steady shower of sparks where abrasive meets iron, bearing striking semblance to the fiery tail of a comet, bombards the sides of the cylinder as the expert mechanic manipulates the complicated machine to reduce the bore to the desired 4½ in. diameter. So accurately must this work be done that the deviation of a mere two thousandths of an inch—the thickness of a hair—is all the workman is allowed. In other words, the diameter must not vary from the limits of 4½ in. to 4½ plus two thousandths of an inch.

Each machine is equipped with a water-cooling arrangement to continually spray the exterior of the cylinder, as the heat developed by the rapidly spinning wheel must be constantly dissipated or else the expansion of the metal will throw out the most expert calculations and result in an imperfect cylinder.

The abrasive wheel, which is of somewhat smaller diameter than the hole to be ground, is secured to the end of a high speed axle turning within a long, tapering spindle which revolves "off-center"—so that the entire circumference of the bore is touched in one revolution of the spindle. At the same time the cylinder moves back and forth on a "carriage," thus providing for the entire length of the bore to be ground uniformly.



At first, in "roughing out," the carriage moves quite rapidly. But as the desired diameter is neared, the speed is greatly diminished and the final traversal occupies over a minute and a half. The finished cylinder is then removed from the machine, touched up where necessary with a fine file and dispatched to the assembling department.

TALES OF LOFTY TUMBLES

The "irony of life" was strikingly illustrated in the newspapers the other day when one read, in the same column, of a rustic who slipped from a 6-barred gate and broke his neck, and of an Italian aeronaut who fell 1,000 ft. with his collapsed balloon with no worse result than a sprained ankle.

It is not long since a French lady, Mme. Morel, and her daughter, while climbing in the Alps, near Zermatt, fell a distance of 1,200 ft. (not much less than a quarter of a mile), and, although the mother was killed on the spot, her daughter escaped with a few bruises. Mr. Whymper, the famous mountaineer, had a similarly miraculous deliverance from what seemed to be certain death when scaling the Matterhorn a few years ago. Losing his footing, he fell from rock to rock to the bottom of a precipitous gully, 100 yd. in depth, only to recover his feet with no worse damage than a badly cut head.

While climbing a waterworks tower 240 ft. high in Chicago not long ago a steeple-jack called Sutherland dislodged a loose stone and was precipitated to the ground from a height of 175 ft., fortunately striking the telegraph wires 40 ft. above the street and thus breaking his fall. The spectators gasped with horror as they saw the man drop swiftly to destruction; a rush was made to pick up his shattered remains, only to discover that he was practically unharmed. Not a bone was broken, and a week later he was walking about as if nothing had happened.

More remarkable, and, indeed, almost incredible, was the experience of Charles Woolcot when he was making a parachute descent in Venezuela. At a height of 3,000 ft. Woolcot flung himself off his balloon into space, when, to the horror of the thousands of onlookers, the parachute failed to open. The man dropped like a stone with terrible speed, until, when about 200 ft. from the earth, the parachute flew open, and at once collapsed. He was dashed to the ground, his right thigh and hip were broken, both ankles and knees were badly crushed, and his spinal column was dislocated.

But it is in the history of ballooning that one encounters the most remarkable cases of sensational drops from the clouds. When Mr. Wise, a famous aeronaut of seventy year ago, was once making an ascent, his balloon exploded at an altitude of 13,000 ft., and began to drop swiftly to the earth, more than a couple of miles below. "The descent at first was rapid," Mr. Wise writes, "and accompanied by a fearful moaning noise, caused by the air rushing through the network and the gas escaping from above. In another moment I felt a slight shock, and looking up to see what caused it, I discovered that the balloon was canting over, being nicely doubled in, the lower half into the upper."

The balloon had, in fact, formed itself into a parachute; and, oscillating wildly, continued its descent until it struck the earth violently, throwing the aeronaut 10 yd. out of his car. "The car had turned bottom upwards, and there I stood," says Mr. Wise, "congratulating myself, the perspiration rolling down my forehead in profusion."—*London Tid Bits.*

How to Test a Silver Solution

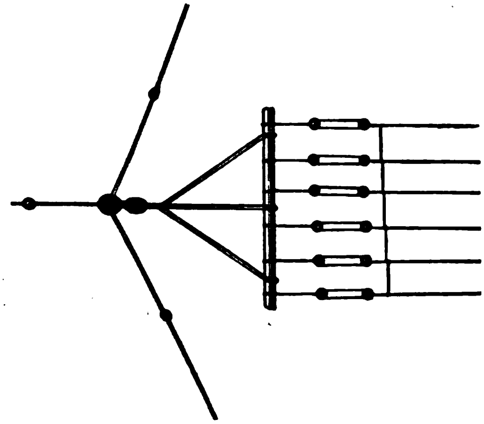
The writer has found the following method of determining the metal in a silver-plating solution to be a very simple, yet accurate, one, says Charles A. Stiehle, in *The Metal Industry:*

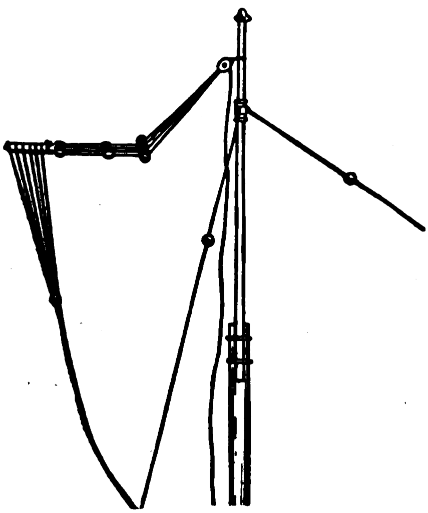
Take 1 oz. of the solution and evaporate in a porcelain dish over a water or sand bath to dryness; then put into a small size clay crucible, about 3 in. high, adding at the same time a few pennyweights of pearl or soda ash. Now put the crucible into the melting furnace, heating slowly at first, so that the contents do not boil over, then give a good heat so that the silver will melt. After taking from the fire and allowing to cool break the crucible, when the silver will be found as a button in the bottom. Now clean the silver from all flux, then weigh, and for each grain of silver in the button, multiply by 142, the number of ounces in the gallon. This will give you the amount in grains that the gallon contains.

WIRELESS TIME-RECEIVING STATION SUCCESSFULLY ESTABLISHED BY KANSAS JEWELER

To E. L. McDowell, of Arkansas City, Kans., belongs the distinction of being the first jeweler in this section, if not in the United States, to have successfully established at his place of business a wireless time-receiving station. Those of the trade who attended the conventions of the state associations last summer will recall the interesting address delivered by H. E. Duncan, of the Waltham Watch Company, on the then new and interesting subject of wireless time service. Mr. McDowell, who believes in the educational value of attendance at conventions, was present at the annual meeting of the national association in Kansas City when Mr. Duncan explained the possibilities of this new service. With a mind alert to new ideas in his line, Mr. McDowell listened attentively, and at once considered the feasibility of establishing such a station at his store. He forthwith consulted with one of the wire chiefs at the local Atchison, Topeka and Santa Fe relay office in his city, and together they planned the erection of the station.

The aerial poles are 42 ft. high, each composed of three sections of galvanized iron pipe. The bottom section is a length of 2-in. pipe, the middle 1½ in. and the top section 1¼-in. pipe, mounted on insulators. The small pipe is slid inside the larger one 15 in. and drilled, and two bolts are put through them. A five-way





piece is used for the guy wires and top and bottom pipe. An ordinary glass insulator is put on the top of the poles.

Each pole is guyed with three heavily-insulated wires, anchored to nearby buildings. A 2-in. pulley was secured near the top of each pole for elevating and lowering the spreaders of the aerial and 80 ft. of ⅜ in. sash cord was run through each of these pulleys.

The aerial consists of six No. 12 aluminum wires, 70 ft. long, fastened 18 in. apart to bamboo spreaders 9 ft. long. Each wire is insulated from the spreaders by two insulators at each end. The wires are then all connected by a wire across the ends. Mr. McDowell is not certain that it is necessary to have the lead-in wire attached to each of the six serial wires. Two, he thinks, attached to each outside wire might answer, though he states that he got no results till he connected all six wires by cross wires at both ends as shown on aerial. The lead-in wire is made by dropping a wire from each aerial wire to a point 5 ft. below the spreaders, where they are bunched and connected to a No. 10 weather-proof copper wire, which leads to a 100-ampere lightning switch, which is grounded just outside the store. From the switch the wire is carried through a porcelain tube into the store, to the instruments. These are a Blitzen receiving set, as shown at Kansas City.

The lead-in wire is 85 ft. long, and for ground No. 10 water-proof copper wire 40 ft. long is clamped to a water-pipe

under the floor. All connections, including aluminum wires in the aerial, are soldered. The total height of aerial is 70 ft. from the earth and 40 ft. above the roof of the building. The station complete has cost just $125, covering labor and everything.

Mr. McDowell first received the time on November 24, 1912, and has received it in a very satisfactory manner since that date. Quite a little difficulty was experienced at first, owing to interference, as Mr. McDowell informs us that he has telegraph, telephone, electric light and street car wires all running very near the point at which he was compelled to erect his aerial; but after soldering the aerial wires and putting wires across the end, he obtained the desired results. He also had trouble with the ferron detector, which came with the set, and substituted a silicon detector, using a brass point on the sensitive silicon mineral, and met with good success almost at once.

The signals now come in clear and distinct every morning at 11 o'clock and are signed NAH (Brooklyn Navy Yard). He has also heard GO (Chicago), GV (Galveston), Holland, Mich., and many of the steamers on the Gulf of Mexico, and can find at any hour of the day many different stations working, as the Blitzen receiving set gives great selectivity, especially in tuning out all unwanted stations when the time starts. He also caught New Orleans, and thinks he caught Arlington, but is not sure of the latter. It is quite remarkable considering the distance that the Brooklyn Navy Yard signals are clearest of all.

During a recent heavy storm, the sleet and ice so weighed the wires of the aerial that four of the six were broken. It was Mr. McDowell's intention to replace these aluminum wires with No. 14 phosphor-bronze in order to secure greater strength. In the interval, before the arrival of the latter, however, he patched

when new, and can be obtained at any carpet store. They should be shellacked and the ends filled with wax. He obtained from the electric company round porcelain insulators of the desired size, one wire passing around and the other through the insulator. The glass insulators placed on the tops of the poles he obtained from the telegraph company.

The satisfactory results obtained by Mr. McDowell have naturally increased his enthusiasm, and he expressed his willingness to give any assistance he can to his brother jewelers who wish to install a similar time service. It should be kept in mind that the novelty, mysterious character, and absolute accuracy of this service create unusual curiosity in the public, and thus the service becomes a powerful advertisement as well as an institution which the entire locality must appreciate. Mr. McDowell says: "The advertising I have had out of the wireless is worth all it has cost to install. With the Seth Thomas tower clock, a Hawana regulator, and a wireless to receive the time by each day, we are authority for time in this locality.

Arlington, the new government observatory, is located near Washington, D.C., and from this very powerful observatory it is expected that time can be distributed to vast distances. It is calculated that wireless waves travel at a speed which would enable them to make nine circuits of the globe in one second and, therefore, the elapsed time between the sending and the receiving is such an infinitesimal amount that it is not worth reckoning. The waves when sent from Washington are 4½ miles in length. Some time ago The South Bend Watch Company installed a wireless station to get the correct time direct from Arlington, South Bend being 543 miles from the distributing station.—*The Keystone.*

To Remove Verdigris

Mix in an earthenware jar one part

MAKING A SMALL WHEEL PATTERN

H. MUNCASTER

Some time ago the writer was in want of a small flywheel, and not caring for any of the designs on the market, decided to make a pattern for a suitable wheel. From former experience he judged that the making of an actual pattern in wood would be a very trying task, and not at all times satisfactory, such a pattern being fragile, and also liable to warp with damp or heat. The method adopted was so successful, and is so full of possibilities, that it is offered to readers, says *The Model Engineer*, in the hope that it may prove equally serviceable.

The wheel required was to be 4 in. in diameter by 1 in. wide on face, with five flat tapering arms, as shown in Fig. 1. Two pieces 6 in. long were sawed off a piece of 6 in. wide by 1¼ in. flooring board, and roughly planed, back and front. These were mounted (in turn) on the faceplate of the lathe by means of wood screws through the slots in the faceplate, a washer being put on each screw to give a suitable bearing for the head.

No other tool than a ¼ in. wide joiner's chisel was available, but this proved quite suitable, and the wood was faced by the aid of this and a 4 in. hand turner's rest. After facing, an annular groove representing half of the rim, plus the half thickness of arm, was cut into the face (see *A*, Fig. 2). The middle was then cut away a depth equal to the thickness of the arm, and, finally, a ¾ in. hole was cut in the center to form the boss of the wheel. The second portion was mounted in a similar manner and turned to suit the faces (see *B*, Fig. 2), being complementary to the first part, as shown on sketch, the hole in the center being cut right through the wood. The isometrical views of these are shown in Figs. 3 and 4. The arms were then drawn in pencil on the piece *b*, and cut out to the required depth, the outer portion having been cut back previously in the lathe 3/16 in., to allow of this being done conveniently, the turned portions forming a capital means of gauging the depth for cutting the arms. The whole of the work only occupied about three-quarters of an hour.

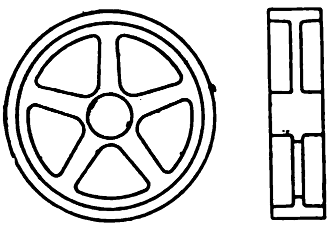


FIG. 1.

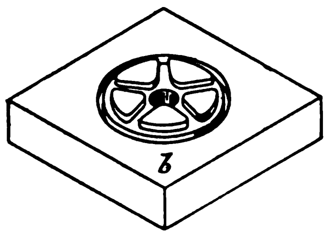


FIG. 3.

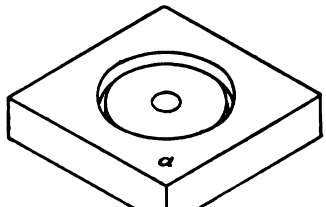


FIG. 4.

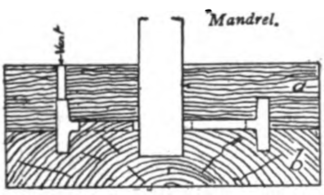


FIG. 5.

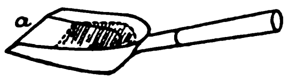


FIG. 6.

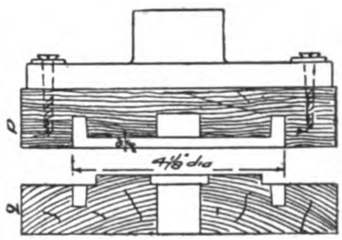


FIG. 2.

The two parts were then put together as shown in Fig. 5, arranged so that the grain of the wood should cross in the different pieces. A ¾ in. diameter mandrel was put through the hole to keep the two parts of the mold central, and a stout wood screw put in at each corner to hold them together, a hole being first bored through to the rim to allow the air to escape when pouring the metal. The mold was thus completed and ready for the metal.

The kitchen fire was then stirred up to make it burn brightly. Having no melting-pot for our metal, the stove shovel

was requisitioned, and as it was moderately deep, was quite suitable for the work, it being only necessary to keep the edge at *a*, Fig. 6, a little above the level. About 1½ lbs. of good solder, containing a large percentage of tin, was used, and about a thimbleful of antimony. The shovel was placed on the fire and the solder melted, then the antimony added, the whole being carefully stirred before pouring. The mold should be set so that the vent hole is slightly higher than any part of the casting; a penny piece was about the right packing when the mold was set on a level surface. The metal was poured from the corner of the shovel into the center hole (the mandrel, of course, having been withdrawn after the parts were screwed together), keeping a steady stream until the metal showed at the vent hole. The metal seemed to shrink to some extent in casting, and a little more metal was added. A piece of ¼ in. rod was warmed, and worked into the hole until the whole had set. After about half an hour the casting was taken from the mold, chucked in the lathe, and turned up, making a beautiful job, perfectly true and clean, and quite hard enough for use as a pattern.

There may be some risk of the metal's escaping from the mold if the faces do not quite touch. This can, however, easily be remedied by daubing clay round the outside, or by placing the mold in a box and packing damp sand or garden soil around it.

Many uses for this method may be suggested, as the making of patterns for boiler ends, cylinder covers, blanks for gear wheels, etc., and the pattern can be melted up when used, if not likely to be again required.

It should be kept in mind that a pattern must be at least ⅛ in. per foot longer than the required casting, and should allow a reasonable amount for any machining that may be necessary to the casting.—*Model Engineer and Electrician.*

STORAGE BATTERY HELPS

S. FRED PILGRIM

The following article is intended for any one who has anything to do with storage cells, and will be especially welcome by commercial operators on shipboard.

When the voltage of the cells falls below 1.75 volts, it is time to recharge them. They should not be exhausted to a lower voltage than this, because by so doing the battery deteriorates very rapidly. Never allow cells to stand discharged.

If, when charging, the temperature of the cells becomes over 100 degrees F., stop the charging until the cells cool again. This heating may be due to too much sediment in the cells; if this is the case, the cells should be taken apart, the old electrolyte removed, the plates and holder washed out, and the cell refilled again. New electrolyte may be made by mixing one part of pure sulphuric

When charged, the voltage of each cell should be about 2½ volts. After the voltage is first brought up to the standard, it will be found that it drops considerably, so after the first charge allow the cells to stand about an hour; reduce the charging current to about half what it was, and again allow the cells to come to about 2½ volts per cell. Generally, the manufacturers of the batteries give the rate at which the cells should be charged; but if not, it will usually be about five amperes. Eight hours should be taken in charging if the cell has been fully discharged.

It is not advisable to recharge a battery until its charge (not voltage) is at least one half expended, and the length of charge given it, if only partly exhausted, should be in proportion to the fraction of the charge which it is estimated to have

A PRACTICAL TESLA COIL

J. PIKE

Many possessors of spark coils may be interested in a Tesla coil which I have made recently. The coil is for the purpose of producing high-frequency effluxes and various experiments for the amusement of one's friends—after the manner dear to the heart of the amateur electrician. For reasons stated further on, no photograph has been made of the completed coil, but details of the construction are here given.

The coil consists of a primary of a few turns of thick wire, or, in this case, of for use with enclosed arc lamps; it measures 7 x 4 3/8 in., and the diameter of the primary was arrived at by taking, approximately, 3 to 2 as the ratio to determine the amount of insulation between the one coil and the other. The glass chimney being nearly 4 1/2 in. in diameter, I thought 6 1/2 in. would be a suitable diameter for the primary, therefore had turned two wood discs 1 in. thick and 5 1/2 in. in diameter, and these, being properly centered, were then drilled through to a size equivalent to a stout

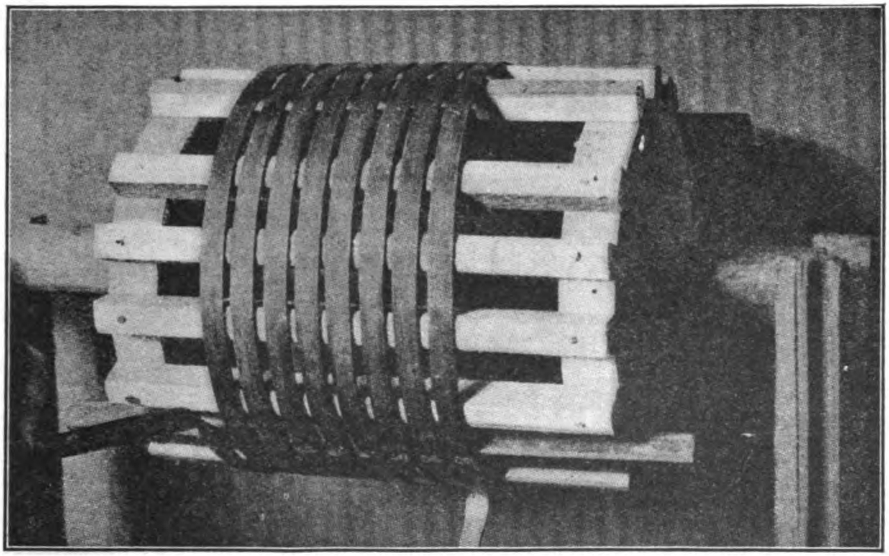


Fig. 1. Showing Method of Building Up the Primary

copper *strip*, 3/32 in. section and 3/8 in. wide, and a secondary of a few hundred turns of fine wire placed inside the primary, the whole immersed in boiled oil, therefore enclosed within a box, which must, of course, be quite oil-tight.

In the first figure will be seen the method of building up the primary, and here I may say that an endeavor has been made to utilize material which is

broom shank. The two discs being placed parallel and about 6 in. apart, strips of wood, 1/2 in. section and about 6 in. in length, were nailed to the edges, as seen in the figure; these 1/2 in. strips, plus the diameter of the discs, bring the turns of copper to an even 6 1/2 in. At two opposite sides are two ebonite or *vulcanized fiber* rods, 9 x 1/2 in. section, the wood rods being spaced between

we must measure carefully the starting-point from which to lay down the strip. The eight turns take up about 4 in.; therefore, if we place a foot-rule over one of the *fiber* supports and make a mark at 2½ in., and at each ½ in. until we arrive at 2½ in. from the further end, the spaces will be about right. Then upon the opposite *fiber* support we make similar marks, but start at 2¾ in. This is, of course, essential, because the primary is wound as a spiral, with ⅛ in. space between each two turns, and this result is achieved by fastening the commencing end (leaving 8 in. or so free) at the side of the 2½ in. mark, then at the 2¾ in. mark on the opposite fiber rod, when, arriving at the full turn, we find the strip falls naturally at the 3 in. mark. The copper must be secured to the fiber supports with brass screws, and, for the most part, two will be required in each case. With a little assistance the copper is easily pressed and bent into place, and screws may be put in as the work proceeds.

The eight turns having been put down, we finish by leaving a spare 8 in. or so for connections, and proceed—if this has not been done before—to put in the *two* screws requisite to properly secure the turns. These screw heads should be neatly flush with the copper or filed smooth, and the part then covered with, say, Chatterton's cement, this merely to cover over any sharp edges or points left in the filing, which otherwise might facilitate sparking between the primary and secondary. This done, the wood and fiber supports may be unscrewed or the nails withdrawn, so that the frame may be detached, leaving the spiral properly shaped, as in the figure. If necessary, and to strengthen the structure, shorter (4 in.) pieces of ebonite or fiber may be put on at additional points—one may be seen in the photograph.

To wind the secondary, the glass

with seccotine, the ebonite rod inserted and fixed in like manner.

We require now to mount the cylinder —for winding—in another stand, which should be just high enough for comfortable working and to admit of a spool of thread and a bobbin of wire (No. 38 S.W.G. cotton-covered) being placed beneath. Fig. 2 is a photograph of the secondary on completion of the winding. One layer only is put on, and each turn is spaced from its neighbor by a turn of the thread. The figure shows an extemporized driving wheel at the side, but this is not much use in practice, it being better and much easier to pay out the wire and cotton with one hand and to revolve the drum with the other hand, which also will be required to properly align the turns. The turns should be fairly

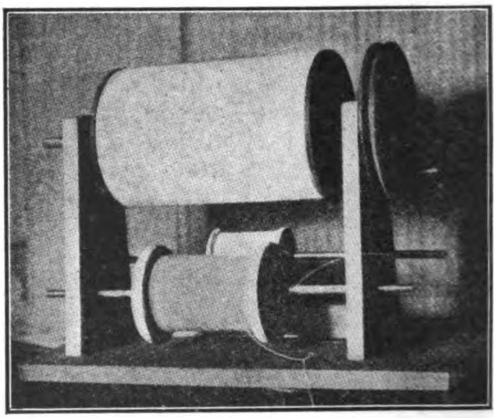


Fig. 2. Showing Method of Winding the Secondary

tight, and, of course, even and close. At the commencing and finishing ends of the drum at least a foot of spare wire should be left, secured temporarily by insertion into a small cut into the wood flange; then a little hot wax secures it permanently.

Some writers advocate the removal of the cotton turns after winding on the

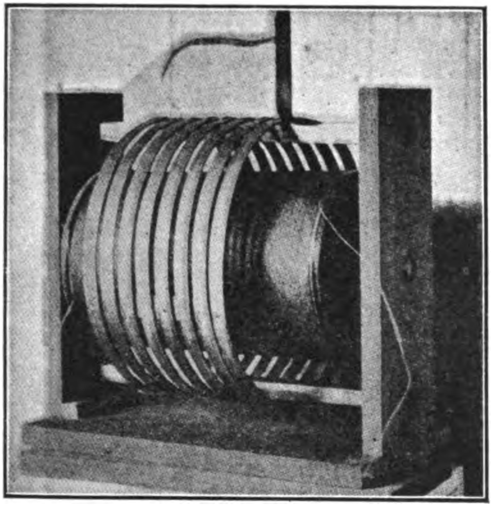


Fig. 3. Showing the Primary and Secondary Coils mounted in Hardwood Stand

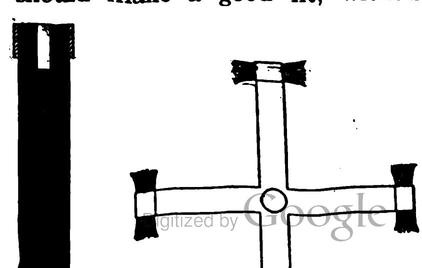
In Fig. 3 we have the two coils (primary and secondary) mounted permanently in a hardwood stand, ready to be placed in the box. Very little description is necessary here. The wood is teak, and the stand—put together without any nails or screws—is just big enough to fit the retaining vessel. When making the stand, one of the sides, after careful measuring, etc., is fixed and the coils put in place; then the other side support is put in, being secured with seccotine or glue. The fiber supports of the primary and the ebonite rod passing through the secondary being of equal length require no further alteration, but may be secured tightly by means of small wedges of wood, if necessary. No difficulty should be experienced in getting the secondary in a central position.

The box to hold this should be very neatly made of teak and the corners dovetailed; it must, of course, be water- or oil-tight, and for this size (10 x 8 x 9 in. inside) be 1 in. thick. The box, being guaranteed tight, is improved by a thorough basting inside with hot paraffin wax; in this way we may line the box out with a layer of wax ⅛ in. thick or so, and be quite safe against leakage.

The ends of the primary are brought to one side and secured there with bind-

be at least 1 in. in diameter, and at the top I find it convenient to fit a piece of brass tubing capped at one end to form a cup, into which—on completion of the coil—various accessories can be placed, *e.g.*, brass balls, terminals, straight brass rods, etc. Fig. 4 shows what is intended. A piece of No. 14 copper wire is soldered to the bottom of the cup after drilling a hole to take one end, and, before fitting on the lid or cover, the fine wires from the secondary are soldered each to one of the wires depending from the pillars.

Two Leyden jars are provided, and they measure 9½ x 4 in., coated inside and out to a height of about ¾ in. with tin-foil, care being taken to get an even coating, *i.e.*, to have the foil in optical contact with the glass. If possible, the inside coating—with the exception of the bottom—should be in only two pieces, these overlapping; but if necessary, three may be used. I presume all our readers know how to make a Leyden jar, so that no words need be spent over the matter beyond stating that the desiderata are the even coating inside and out, the foil being put on with glue—thin, hot, well made, clean, and applied with a fine brush, so that it is no more than a smear of glue. Being placed in a warm, dry atmosphere—more dry than warm—the jars will be ready for use in a week. The brasswork in use with them is for each—a stout brass rod, ¼ in. in diameter, terminating in a large brass ball (1½ in.); this ball is carefully drilled horizontally to take a smaller rod (fitted with short ebonite handles), which in turn terminates in a smaller brass rod (1 in.). As these balls form the spark gap, they should be arranged so that the height is the same in each case, and the rods should make a good fit, without



being tight. In place of the usual caps or lids I use ebonite discs—1/16 in. thick, cut with dividers to make a good fit inside the jars (top end). These discs, being drilled through their centers, are pushed on to the upright rods so that the latter are kept in a vertical position. The discs should be within an inch or two of the top in each jar. The simplest way to secure them in position is to cut out of brass tubing collars to make a good fit on the rods—two for each. These little collars are sawed through on one side and given a slight grip between pliers to ensure a tight fit. One is pushed over the rod to the height requisite, the disc is put in place, and the second then

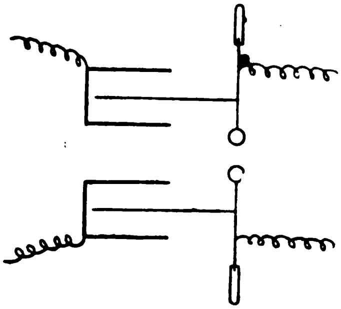


FIG. 6.

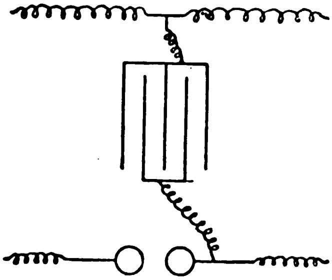


Fig. 7

secures it in position. The rods, balls, collars, etc., should all be highly polished and free from sharp edges, and so on. At the bottom of each rod is fitted with solder a piece of thin sheet brass, cut cross-wise and bent to fit the bottom of the jar. The arms of the cross are about ½ in. longer than necessary to fit, to make room for a small tuft of fine wire (a piece of the best silk-covered flexible lamp wire will supply this, see Fig. 5). tightly. We get in this way four excellent contacts in the bottom of each jar.

The secondary terminals of a spark coil—6 in. at least—are connected to the inner coatings of the Leyden jars, and an adjustable spark gap is arranged between them, see Fig. 6. The coil being started, one of the jars becomes charged with positive and the other with negative electricity, and when the e.m.f. is sufficiently high a spark leaps across the gap.

The outside coatings of the jars are connected to the primary (of the Tesla coil), and the e.m.f. of the oscillating currents is raised by induction, by providing the secondary coil of fine wire, which in this case is placed inside the primary. Very fine brush discharges are produced at the terminals of this secondary.

The discharge between the balls of the spark gap appears to the eye as one single spark, but it consists actually of a succession of extremely rapid electrical oscillations or waves. As long as the inner coating of the jar is charged with positive electricity the outer coating must be charged with a similar quantity of negative electricity. As soon as the spark leaps over the charge disappears, but on account of the change the outer coating becomes positively charged, and this again induces a negative charge on the inner coating. It has been calculated that the sparks follow one another in an opposite direction with an interval of about one-millionth part of a second, and on account of their rapidly oscillating character comes the term "high frequency" currents. Every change of potential taking place on the inside coatings induces a similar change of the same intensity, but in an opposite direction, on the outer coatings, and these latter are connected to the Tesla in the manner indicated.

Another way is to provide a separate and adjustable spark gap, and to use either one jar only or the two in parallel (see Fig. 7). In this case the outer coatings of the jars—which may stand upon a strip of tin-foil—are connected to one of the secondary terminals of the spark coil and to one of the primary terminals of the Tesla. The inner coatings are connected to the other secondary

The physiological effects from the secondary terminals of the Tesla coil will be found entirely different from those of the spark coil. The latter must always be treated with the greatest respect, and no one is likely to forget a shock from a large coil. Referring to Fig. 7, we may say roughly that all that part of the apparatus to the right hand must not on any account be touched while the "spark coil" is at work; *always* switch off the current before attempting any adjustment of the apparatus. With regard to the Tesla coil, however, one need not be so particular with the apparatus arranged as Fig. 6, as it should be in the usual orthodox way for medical use. We may take sparks from the Tesla secondary with impunity; that is to say, there is no shock whatever. Arranged as in Fig 7, we do experience slight shocks if the finger is approached hesitatingly to either of the Tesla secondary pillars; but if we take a brass rod in the hand and approach it to the pillar, we may take big sparks therefrom and feel nothing.

The current should, however, be *always switched off* before making any fresh adjustment of the jars or spark-gap.

One important modification remains to be mentioned, and this is a simple method of tuning the apparatus. The primary coil, Fig. 3, is made with eight turns of copper strip, and, other things being equal, this may be, for the size, correct; but it is well to have an arrangement whereby we may cut out two or three of the turns, and this may be done by proceeding as follows:

Premising that the finished coil in its case is not particularly ornamental, and is therefore not pictured, and nothing would be shown thereby to be of any value, the reader will imagine a cube of about 11 in. each way. The two terminals of the primary will be on one side and those from the secondary on the other, taken up through ebonite pillars, as described. Now before placing the lid or cover in position, the position of the primary turns should be carefully measured, so that if we drill two, three, or more holes in the lid, a copper or brass rod thrust through one or other of them will make contact with a turn of the copper strip. Now imagine one of the wires from the outside coatings to be fitted with a short piece of brass rod, and instead of inserting into the binder provided for it, push it through one of the holes in the lid, so that seven, six, or five only of the turns are used. The rod should make a decent fit in the lid, as it is required simply to make contact by touch. It is not possible in this apparatus to move the primary, otherwise the turns in use should be fairly central to the secondary winding, but this difficulty may be overcome by making holes for each turn and using a similar rod for the other wire. In this way we could cut out the two end turns, at any rate, and thus use six turns, all placed centrally over the secondary. Another point is to drill these holes diagonally, so that the pins or rods may be as far away as possible from the secondary pillars. Testing the apparatus figured, I found no essential difference using six turns or eight, as sparks were emitted in profusion between the secondary pillars, 8 in. apart.

The results will largely depend upon the efficiency of the induction coil used; a coil which gives a long, thin spark, even if continuous, is not so good as one which gives "fat" sparks. The Leyden jars also will modify the results. Carefully made and equal to professional work, the output will be very gratifying. —*The Model Engineer and Electrician.*

Artificial Ebony from Oak

The blocks of wood are immersed for 48 hours in a warm saturated solution of alum and sprinkled several times with a decoction of logwood; smaller pieces may also be steeped for a certain length of time in the decoction, which is prepared in the following manner: One part of logwood of best quality is boiled with 10 parts of water; it is then filtered through linen and the liquid evaporated at low temperature until its volume is reduced by one-half, and to every quart of this bath are added 10 to 15 drops of a saturated solution of soluble indigo entirely neutral in reaction. After having watered the blocks several times with this solution, the wood is rubbed with a saturated and filtered solution of verdigris in warm concentrated acetic acid, and this operation repeated until a black color of the desired intensity is obtained. The oak wood dyed after this fashion is said to present an aspect similar to that of real ebony. The method is obviously unwieldy for large surfaces, even if satisfactory in other ways.

OIL AND GAS ENGINE DEVELOPMENT

JOHN CREEN

The well-known disadvantages of the caloric, or "hot-air," engines have been largely overcome by the late improvements in gas and oil engines. These latter have also a much greater efficiency than steam engines, especially if efficiency is calculated on the basis of the heating effect of the fuel required to operate a steam engine, with that necessary to operate a gas motor of the same horsepower. In a simple gas engine a mixture of inflammable gas and air fills a portion of the cylinder in which the piston moves, and when this is ignited (by electric spark or otherwise), it explodes and propels the piston with corresponding force to the opposite end of the cylinder; then by the action of the fly-wheel or balance-wheel the piston returns, partially taking in another charge of gas and air, which, by exploding, moves the piston in the opposite direction. In other gas engines the movements of the piston are so arranged that the explosive mixture of gas and air is compressed before it is ignited.

Gasoline, benzine and oil motors are operated on the same principle as the gas engine, the explosive gas mixture being formed by passing air through gasoline, which thereby becomes charged with the requisite amount of inflammable gasoline or benzine vapors, which behave in the motor in the very same manner as the mixture of gas and air. Such liquid fuel motors require about one pint of gasoline per horse-power per hour, while an engine operated with natural gas requires from 12 to 20 cu. ft. of gas to produce the same effect, and of illuminating gas about 10 to 30 per cent. more.

The development of large gas engine units has been going steadily forward during the last fifteen or twenty years, and probably the first large engine of this class was that exhibited by the John Cockerel Company at the Paris Exposition in 1900. This engine was rated at 600 h.p. At the present time, 1,500 h.p. in each cylinder of the four-stroke-cycle type, and 2,000 h.p. in each cylinder of the two-stroke-cycle engine, have been is prepared to install gas engine plants of large power capacity at a cost not exceeding, and in some instances less than, that of a corresponding steam turbine installation.

Various methods of utilizing the waste heat of the gas engine exhaust have been attempted from time to time, and the demand for such devices has been large. In this connection it may be stated that the expansion of a gas while propelling a piston may be allowed to proceed, while the energy imparted to the piston is replaced by heat supplied to the expanding gas from without; the expanding gas is kept at the same temperature, and therefore it is said that the expansion proceeds isothermally. This operation may also be reversed and work converted into heat by applying the power gained by raising the piston, to push the piston back, and withdrawing the heat liberated by the work of compression as fast as it appears, so that the gas is always at the same temperature. The heat energy of a gas is independent of its volume, and the energy of a mixture of gases is equal to the sum of the energy of its constituents.

Several schemes for utilizing the waste heat from the gas engine are at present commercially in use, but according to recent opinions the most efficient method of using the exhaust is through a combination of gas and steam engines. Present practice indicates that about 3 lbs. of steam are generated per brake horsepower hour, by means of boilers heated by the exhaust. According to Mr. A. L. Chorlton, the use of exhaust boilers with efficient steam engines, and specially-designed gas engines of the two-cycle type, will effect marked thermal economies and reduce the initial cost per horsepower of the installation. One of the technical journals states that Mr. Chorlton shows by numerical examples the possibilities of such an engine, first examining the case of the addition of a steam end to a normal economical gas engine. He assumes a standard engine

of this heat to be recoverable. From this at 80 per cent. efficiency of conversion, at 100 lb. pressure, there would be recovered about 2½ lb. of steam per brake horse-power hour. This amount of steam in an ordinary simple steam engine would not give more than 10 to 12 per cent. of the main engine power, a return that scarcely justifies the first cost of the steam cylinder; consequently no development has taken place in this direction. When, however, one deals with a special combined compound engine, each part of which is made in the way most suitable for the purpose required, a very different result is obtained. In order to reduce the cost of the gas engine part, the compression would be lowered, and, with the ignition retarded, a much lower maximum pressure and temperature would result; the total British thermal heat units used would go up to about 12,000, but more would be rejected to the exhaust, and with a special arrangement of boiler, economizer pipes, superheaters in exhaust, etc., 50 per cent. of the waste should be recoverable. There should be obtained from this 4 lbs. of steam per brake horse-power hour. The steam cylinder used would be similar in type to that of the two-cycle engine—that is, with no exhaust valves. The unidirectional flow-engine of this type has been largely adopted in Germany with very economical results. The jacketing of the ends can be accomplished by exhaust gas. For small engines of this type it is safe to assume a steam consumption of 12 lbs. per brake horse-power hour; a consumption of 10 lbs. has been obtained in actual practice.

Although the steam turbine has to a certain extent superseded the reciprocating steam engine for the generation of electricity in central-station work, and will probably hold the field for some time to come, it is interesting to note that the Diesel engine, owing to its great success in small-station work, is now looked upon seriously as a possible rival to the steam turbine.

In a paper recently read before the Municipal Electrical Association at Brighton, England, the relative cost of a 10,000 k.w. installation for steam turbines, gas producers and engines, and Diesel engines was discussed at length, the author proposing the use of seven sets each of 1,450 k.w. capacity. His figures on operating expenses, etc., are decidedly in favor of the Diesel engine. Attention was also called to the very economical use of these engines as a substitute for substation converting machinery, and such stations are already in operation, and others in course of construction in London.

The Diesel engine is somewhat of a cross between a hot-air and oil engine, and is based on the principle that the air portion of the explosive gas mixture is compressed and incidentally heated by the motor before the oil or other liquid fuel is introduced, thereby causing the required ignition under conditions which are claimed to insure a higher efficiency of the fuel than any other motor.

It is also noteworthy, in connection with the Diesel engine and its development, to refer to its rapid increase in size and power. Engines of a few hundred horse-power have become common in Europe. In many electric stations in Switzerland, Diesel engine units of 2,000 h.p. are at present in use; and it has been recently stated that the development of the large size Diesel engine has been so successful that it will not be long before 1,000 h.p. developed in one cylinder will be nothing extraordinary.

One company of world-wide reputation is at present considering more than 2,000 h.p. in a single cylinder of the Diesel engine. It is stated that engines of this type, with four cylinders, developing 1,000 h.p. each, can be made as light as the corresponding triple-expansion steam engine. Further, the weight of such engines compares favorably with that of the corresponding turbines and boilers; and it is on record that a 1,000 h.p. installation of this type weighed only 187 lb. per horse-power, as against 180 lb. for a steam turbine and boiler installation.

Perhaps one of the most interesting features of the Diesel engine development is its application to marine propulsion for almost all types of vessels and submarine craft; and it is now being used by many of the principal navies of the world for the latter, while designs are now under way for comparatively large engines for torpedo boats, destroyers, etc. Russia is credited with at least four freight vessels of 1,000 h.p. and two 14-knot gunboats of the same horse-power

rating. In December, 1911, two vessels, nearly 400 ft. long and of 7,000 tons capacity, each fitted with Diesel engines of 2,500 h.p., and with two auxiliary Diesel engines of 500 h.p., were tried out in European waters.

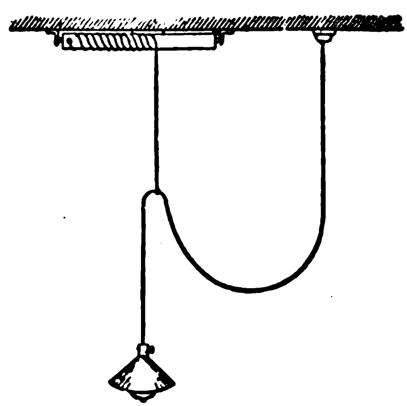
An interesting comparison will shortly be placed before the public by the British Admiralty, which is preparing to try out, side by side in a twin screw cruiser, a steam engine and a Diesel engine of 6,000 h.p. each. A destroyer recently ordered by the British Admiralty will have on each shaft a steam turbine and a Diesel engine. The plan is to operate the turbines when high speeds are required, but under cruising conditions, when the speeds are low, owing to the poor economy of the steam turbines, the Diesel engines will be used. The combined economy from this arrangement will be exceedingly interesting.

In the foregoing connection, a brief reference ought to be made to the maiden voyage of Motor Ocean Liner *Selandia*. This is the first cargo and passenger vessel which has made so long a round voyage (21,500 miles) entirely independent of the use of steam power. In spite of the fact that the vessel embodies many new principles, and was strange to its engineers, only one slight adjustment of the exhaust valves, involving a fifteen-minutes' stop for the engines, was found necessary during the entire trip. In all matters of fuel consumption, ease of manouvering, and general behavior, the engines far exceeded expectations. Very few alterations in design are suggested by the experience of the engineers on the maiden trip, and these relate chiefly to the heat radiated from the exhaust, which affected the temperature of the engine room. The trouble has been corrected on the *Selandia* by the installation of supplementary fans and ventilators, and will be avoided in future boats, by the natural cooling of the exhaust chambers above deck. The fuel consumption fell considerably below that estimated by the builders; on the home voyage the *Selandia* averaged ten nautical miles per hour on a consumption of 8.5 able rates at Singapore than in any European port. The opening up of all gears and bearings at Copenhagen on the completion of the voyage, and the inspection by Lloyd's representatives at that port, showed that everything was in perfect order, and that no parts had suffered undue strain. The temperature of the water cooling the cylinders at no time exceeded 40.6 degrees Centigrade, although 53 degrees had been previously established as a working maximum.

Although steam engines probably will not be rapidly displaced in the larger ocean-going craft, yet the crude oil engine seems to be especially adapted to a great number of services in marine propulsion. The quantity of fuel needed approximates a third of that required for the steam engine, hence the radius of action for a given weight of fuel is greatly increased; further, the boilers can be eliminated, and the space utilized for carrying cargo.

A Workshop Lighting Hint

A correspondent of the *American Machinist* says: "I find that there is no handier way of hanging an incandescent lamp, either for use on a machine or vise, than the one shown in the accompanying sketch. Simply take the stick of an old spring window blind, cut it to a suitable



Method of Hanging an Incandescent Lamp in Workshop

length, and attach it to the ceiling or any place directly above the spot where the

GEAR WHEELS AND GEARING SIMPLY EXPLAINED—Part III

ALFRED W. MARSHALL M.I.MECH.E., A.M.I.E.E.

When the shafts between which the rotation is to be transmitted are not parallel to one another, conical toothed wheels, called bevel wheels, may be used. They have peculiarities, and are difficult to construct so that they will work properly together, maintaining the relative velocities of the shafts. If the shafts are at right angles and the wheels are of equal size, they are then often called miter wheels. When planning a pair or train of bevel wheels the first step is to imagine them as cones with smooth surfaces rolling against each other and transmitting the motion by frictional contact, Fig. 27. The relative velocity of cone *W* to cone *P* will depend upon the diameter *AA* of cone *W* to the diameter *BB* of cone *P*. If these diameters are equal, cone *P* will make one revolution for each revolution of cone *W*. If any other diameters which are in contact, such as *CC*, *DD*, are selected, they will be in the same proportion to one another as the large diameter *AA* is to *BB*. We can imagine a series of such pairs of diameters between the bases and points of the cones, and each pair will bear the same proportion to one another. The entire surfaces, therefore, of the two cones, roll together with the proportional velocity of the large circles *AA*, *BB*, and the entire surface of each cone forms a pitch surface of that cone. We could thus correctly select any pair of diameters upon which to form the pitch circles of the cones. In practice the circles formed upon the largest diameters *AA* and *BB* are selected as the pitch circles. To drive one shaft by the other at any relative number of revolutions you should thus make the sizes of the circles forming the bases of the cones in proportion to the desired relation between the revolutions of the shafts. Thus, if shaft *B* is to make one complete revolution while shaft *A* makes one revolution, you should design the base *AA* of cone *W* so that it has a diameter equal to the base *BB* of cone *P*; if shaft *B* is to make one revolution while shaft *A* makes two revolutions, the base of cone *P* should be designed with a diameter twice as large as the diameter of the base of cone *W*, Fig. 28; and so on. The bases of the cones are equivalent to the pitch circles of flat gear wheels, and the shafts which they connect will rotate with relative velocities proportional to the diameters of the bases of the cones. In these explanations it is assumed that the axes of the shafts intersect. This is the condition usually met with in practice.

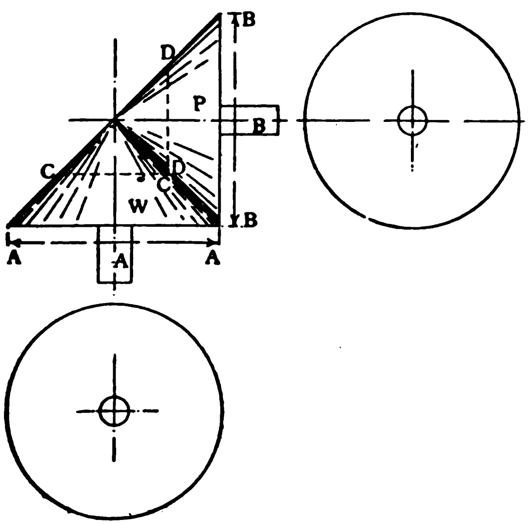


Fig. 27

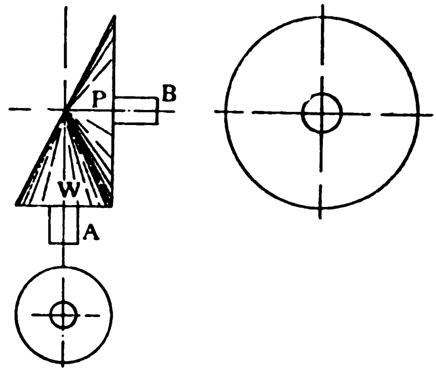


Fig. 28

Such a pair of cones, made of wood, metal, or other material, will transmit the motion of one shaft to the other by contact friction between the surfaces. If they are large in proportion to the amount of power to be transmitted and conditions of working are favorable,

the friction may be sufficient and no slipping occur. To prevent slip, teeth may be provided, as in the case of flat gear-wheels. This introduces a difficulty, as the teeth and spaces must be conical and follow the shape of the pitch surfaces of the cones. For example, if we construct teeth of similar shape and character to those used for flat wheels, they must be made to taper from the base to the point of the cone, as indicated by the shaded surfaces, Fig. 29. If they are made of uniform height and thickness, or of less angle of taper than would terminate in the point of intersection of the pitch cones, they could not work together, but would foul and break off if sufficient power was applied to drive the shafts. Every part of the surface of each tooth—the faces and flanks as well

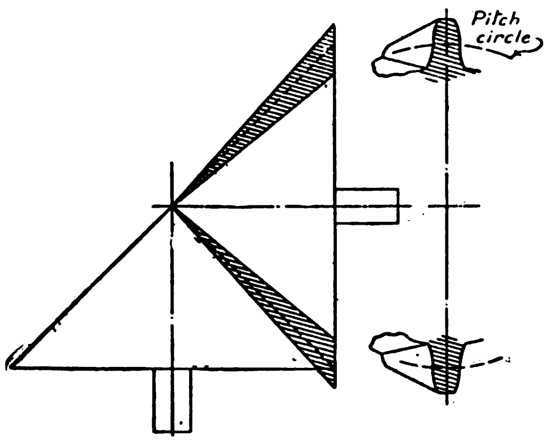


Fig. 29

as the tops—must be conical, the taper coming to a point at the intersection point of the pitch cones. The teeth, if properly made, will, therefore, become very thin at the parts which are near to the points of the pitch cones, finally vanishing away. Only a portion of the length is of practical use, and bevel wheels are never made to the complete theoretical extent of the pitch cones, the breadth is usually made equal to one-third the distance *D*, Fig. 30. Each wheel thus becomes a truncated cone, but is actually part of a complete cone, as indicated by the dotted lines, Fig. 30.

This principle of rolling cones permits considerable latitude in selecting the size of the wheels, and in this respect the problem differs from that of connecting two parallel shafts by flat spur wheels.

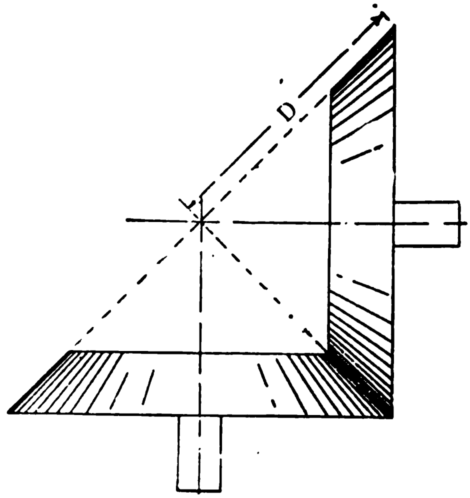


Fig. 30

In the latter case the size of the wheels is limited by the distance between the shafts, but when the shafts are at an angle the wheels may be of any size within the limits of the space of the machine or the surroundings of the shafts. For example, in Fig. 31 the shafts *A* and *B* are to be connected by the wheels so that they rotate with equal velocities. Wheels of size *CC* may be used, or of size *DD*, or any intermediate size, without affecting the relative speed of the shafts. Both pairs of wheels could be used simultaneously, because all bevel wheels on either shaft having pitch surfaces meeting on the line of the two cones, indicated by the dotted lines,

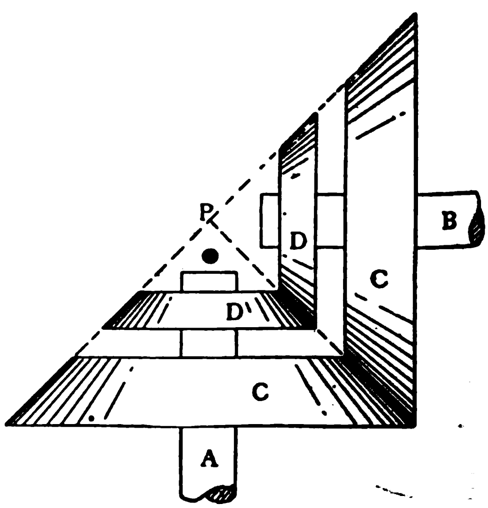


Fig. 31

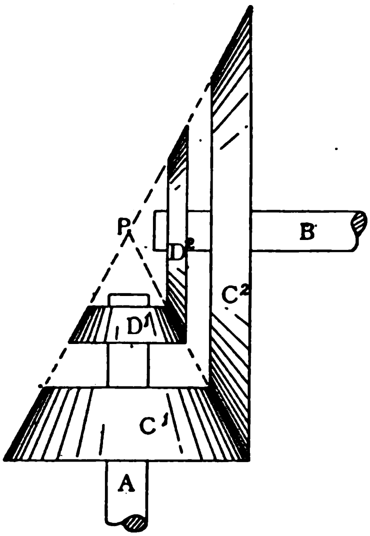


Fig. 32

are really a portion of one large conical wheel, the teeth and pitch surfaces of which extend from the point to the base of the largest wheel. The principle is not affected if the shafts rotate at different relative velocities. For example, in Fig. 32 shaft *A* makes two revolutions to one revolution of *B*. The wheels may be of size *CC* or *DD*, or any other size, provided their pitch surfaces form part of the cones indicated by the dotted lines. The relative numbers of teeth must remain the same or be in the same ratio. If *C*1 has 30 teeth and C2 60 teeth, *D*1 must have 30 teeth, and *D*2 60 teeth, or numbers of teeth having a ratio of 1 to 2; thus *D*1 could have 15 and *D*2 30 teeth,

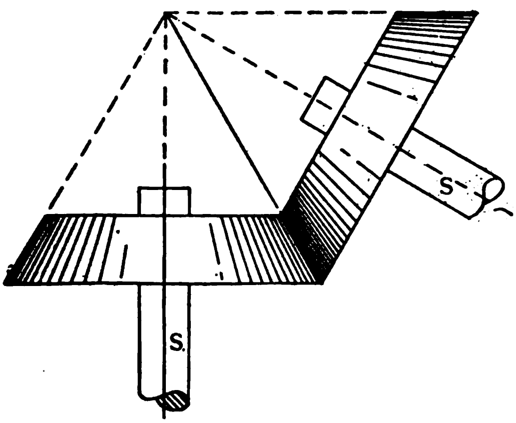


Fig. 33

and so on. The sizes of the wheels to connect a pair of shafts whoses axes are at an angle can therefore be determined by matters of convenience and strength required to transmit the power. Obviously a large pair of wheels can have teeth of greater size than a smaller pair. If the shafts are not at a right angle to one another the principle of rolling cones is still applicable, if the axes of the shafts intersect. Fig. 33 is a diagram showing two shafts intersecting at an angle of less than 90 deg., and Fig. 34 shows the shafts intersecting at an angle greater than 90 deg. in each instance the cones have equal diameters, so that the two shafts will rotate at equal speeds. The shafts may be made to rotate at different speeds by designing the cones so that their diameters are of corresponding proportions to the speeds, as in the case of shafts at a right angle. Fig. 35 shows the principle of rolling cones applied to an internal gear connecting two shafts *SS*, which are at an

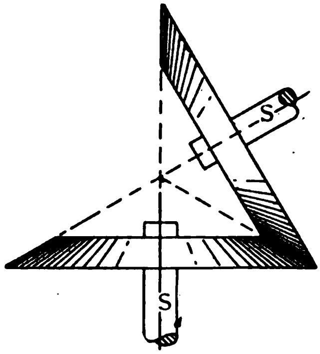


Fig. 34

angle. In this arrangement the wheel *P* must be smaller than the other, as it is a pinion working inside an annular wheel.

The term crown wheel and pinion is sometimes given to the gear shown in Fig. 36. Correctly speaking crown wheel is another name for bevel wheel, and the gear shown in Fig. 36 should be formed on the principle of rolling cones. If the wheel *W* is made with straight teeth and a cylindrical pinion *P* is used to gear with it, the arrangement will not work correctly. The wheel may be represented by a flat disc *W*, Fig. 37. In fact, its pitch surface would be a part of such a disc. The pinion would

be represented by a cylinder P, rotating in contact with the disc; such a cylinder would form the pitch surface of the pinion. Obviously all parts of the circumference of P must move with the same velocity. But all parts of the surface of the disc will not move with the same velocity. That part represented by the dotted circle C will have a much greater surface speed than the part represented by the dotted circle D. As both parts are in contact with the circumference of P, the circle D will be trying to drive P at a slower speed than it is being driven by P. Every part of the surface between C and D will, therefore, be trying to rotate P at a different rate of speed. As P can only rotate at one speed at any instant, a slipping and grinding action must take place between the surfaces. If the surface of the disc is cut away so that only a circular ridge is left in contact with P, such as would be represented by the

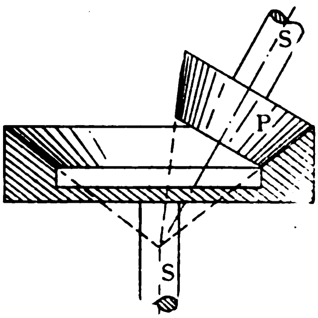


Fig. 35

circle C, this action would be reduced to a minimum. The gear shown in Fig. 36 can be, therefore, made to work if the teeth on W have very small breadth, as indicated by the sketch, so that they make very narrow contact with P. Such a wheel can then only transmit or receive a very small amount of power or its teeth will soon wear away. When the diameter of the wheel is great compared to that of the pinion, the error in the shape of the teeth as regards taper is small, as indicated by the dotted sketch Fig. 36, but it still exists.

The teeth of bevel wheels are formed on the same principle as the teeth of flat wheels, but the shapes of the faces and flanks are not developed upon the actual pitch circles. A section through

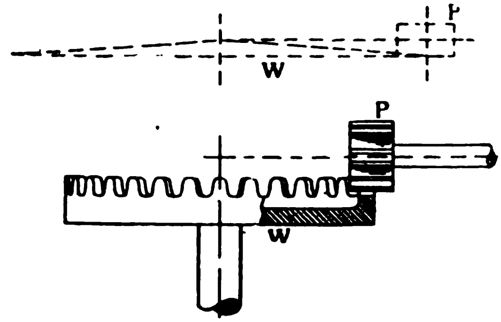


Fig. 36

a tooth which would show its actual shape would not be in a plane parallel to the base of the pitch cone as indicated by the teeth shown by Fig. 29, but would be in a plane perpendicular to the conical pitch surface. The teeth are placed so that they are perpendicular to this pitch surface; therefore, it would not be correct to develop their shape by curves generated on the circumferences of the pitch circles. They are developed upon circles CC of larger diameter, as indicated by Fig. 38, the centers and radii being found by drawing lines B at a right angle to the pitch surfaces, and meeting the centers of the shafts at DD. The circles upon which the curves of the teeth are formed are then found by radii equal to the distance from D to the edge of the pitch circle. The numbers of the teeth are calculated with reference to the pitch circles PP, and not with reference to the circles CC. The pitch is merely applied to the circles CC and the teeth shaped by rolling curves, as in the case of flat wheels, as if CC were the true pitch circles, but it is kept the same as found by dividing the circumference of the true pitch circles PP by the required numbers of teeth. Only

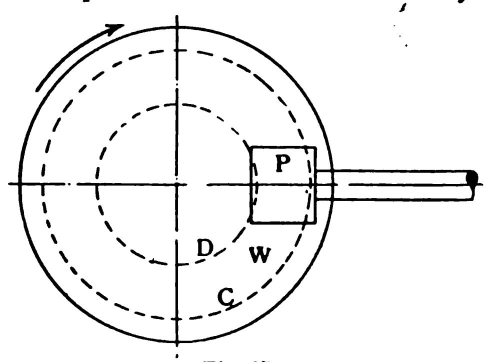


Fig. 37

a part of the circumferences CC is therefore required, in fact, sufficient only for the motion of the curve generating circles. This question of shaping the teeth need not concern you if you are merely preparing a blank to send to a wheel cutter; it only concerns anyone who is actually shaping the teeth. The necessary thing is to make the blank of sufficient size and suitable shape to be cut. Sufficient margin must be allowed above the conical pitch surface to form the part of the teeth which projects beyond the pitch circle. The amount necessary for this is found by adding a part T projecting above the pitch surface, and the dimensions S is the depth to which the spaces will be cut below the pitch surface. The small ends of the teeth are terminated parallel to the lines B. The inner face of the wheel is, therefore, recessed as indicated at R. The lines of the sketch indicate the manner in which the teeth taper towards the point O, where the axes of the two shafts intersect. This is also indicated at V, where the small ends of the teeth are shown developed upon a circle W, concentric with C, and having a radius YZ, found by drawing a line from Z to Y perpendicular to the conical pitch surface of the wheel. A complete blank

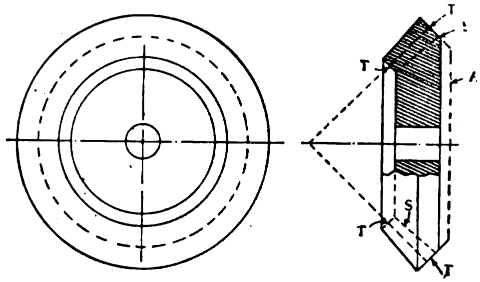


Fig. 39

ready for cutting the teeth would have an appearance as indicated by the sketch Fig. 39, which is partly in section. The dotted lines SS indicate the depth to which the teeth will be cut.

It is usual to make the thickness of the wheel somewhat greater as indicated by the dotted line A, to avoid a weak edge at the bottom of the spaces between the teeth. If a pattern is being made and the teeth cut out by hand, the curves for the faces and flanks must be applied to the surfaces TT, either by a template or by setting out with compasses, having been found by construction or development on the circles C and W, Fig. 38. A consideration of the tapered form of the teeth will show the difficulty of shaping them by cutters in a machine. In fact, when cut by milling cutters, they usually only approximate to the correct form, and some methods of cutting leave a certain amount of shaping to be done afterwards by filing. The general idea being to produce the teeth as correctly as possible by the cutter at the large end.

The general rules for shapes of teeth of flat wheels also apply to the teeth of bevel wheels; they may be on the cycloidal or involute systems. One wheel may be of the lantern pattern, as Fig. 20, and have pins for teeth; such a pair of wheels have their teeth shaped precisely upon the same principles as the teeth of a flat wheel, and lantern pinion. When the teeth are produced by a circular milling cutter they should be of involute form, as the cycloidal shape is extremely difficult if not practically impossible to obtain by this method.

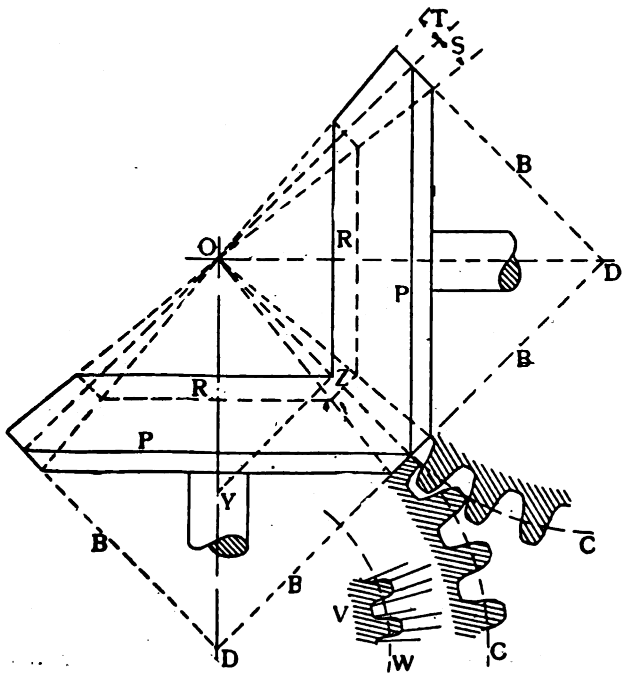


Fig. 38

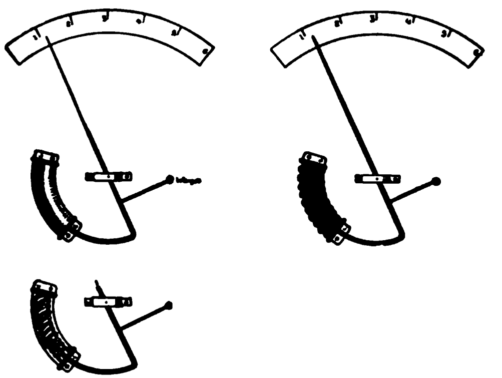
(*To be continued*)

CONSTRUCTION OF A VOLTMETER AND AMPERE-METER

LLOYD H. ORDWAY

The principle of both of these instruments is a solenoid and a soft iron core—movable, and connected to the pointer so that any variation in current or voltage is indicated on the scale. It is the type of instrument once standard with the Edison companies.

The construction of both instruments is identical, with the exception of the solenoids. The first thing necessary is to draw a circle with a $2\frac{1}{2}$ in. radius, then, using the same center, another circle of $2\frac{11}{16}$ in. radius. Now, draw a line from the center to the large circle. Next, get a piece of copper or brass tubing, about $\frac{5}{16}$ in. inside diameter by $\frac{1}{32}$ in. wall, and about $3\frac{1}{4}$ in. long. Fill it



with melted lead or rosin, and, when hard, bend it so that it will lay along the arc of the larger circle. The center of the tube when laid on the drawing should about line up with the inner circle. Melt the lead or rosin out of the tube, fit heads of wood or hard rubber 1 in. in diameter, cover the tube with several layers of paper and wind full of No. 22 magnet wire, bringing the two ends out for terminals.

Now, with a couple of narrow strips of thin copper, strap the coil to the wooden base and bring the two wires ... binding-

inner circle, mark the center on the wire to coincide with the center of the circle. Drill a hole here and solder in a $\frac{3}{4}$ in. piece of a needle that has been ground to sharp points on both ends so as to serve for a pivot. Now flatten with a file about $\frac{1}{2}$ in. of the end of the straight portion and solder a piece of thin sheet copper cut to the shape of a pointer.

Next, make a U-shaped yoke to form a bearing for the pointer; and bear in mind this bearing must have the same relative position with regard to the coil as the center does to the circle, since the iron wire must float within the solenoid without touching the sides.

When the pointer sets at zero, the end of iron core should enter the solenoid about $\frac{3}{16}$ in. If it does not, place a weight made of a drop of solder on the end of an arm and solder it to the core in the position shown. A little experimenting will bring this right.

If this instrument is too sensitive, place a resistance of German silver or iron wire in series with it.

The ammeter is of exactly the same construction, except that the solenoid is made of a single layer of large, bare copper wire about $\frac{1}{4}$ in. in diameter, but the size will depend upon the current to be measured—No. 6 may be ample. It is wound around a $\frac{5}{16}$ in. rod very tightly, using a pipe wrench to wind it. Then with a screw-driver force the convolutions apart on one side until the center of the coil coincides with the arc of the circle. Now, be sure all of the turns are separated so as not to make contact, and then strap it down as was the coil on the voltmeter, but taking care to insulate the straps from the coil by strips of cardboard. This instrument is not very sensitive, and so the movable member must be very carefully made. If it is not sensitive enough to suit, cut down the air gap between the coil and core by

SMALL DYNAMO AND MOTOR TESTING

BARTON MOTT

This article is intended to give in a short space a general plan of operations for testing small dynamos and motors. With most small models it is not practicable to test them in the same way as one would a large machine. The principal objects in view in the testing of a small machine, say up to ¼ h.p., are to observe the behavior, with regard to sparking, overheating, etc., while running at full load, and to find the energy required to enable it to give the best results. For this purpose the machine is tried under various conditions in a place where adjustment and alterations can easily be made.

First, during construction, every coil should be tested by means of a battery and galvanometer just as soon as it is wound, in order to make sure that the winding has not broken anywhere, as sometimes happens with old wire, and to see that the coil is properly insulated from the core. A battery of about six cells will prove very useful for these tests. Fig. 1 shows the connections for testing a section of the armature winding. If the wire has not broken, the galvanometer needle will jump to one side every time the circuit through the winding is closed. The test for leakage is made by joining the wire from the galvanometer to one end of the winding; then, if there is no movement of the needle, when the wire from the battery is touched to the core or frame of the machine, there is no leakage. The insulation of that winding is correct. Slight movements of the needle during this leakage test may be the result of dampness, caused by the spirit in the varnish.

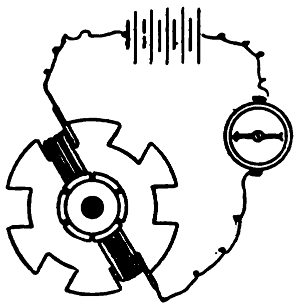


Fig. 1. Testing Armature Winding

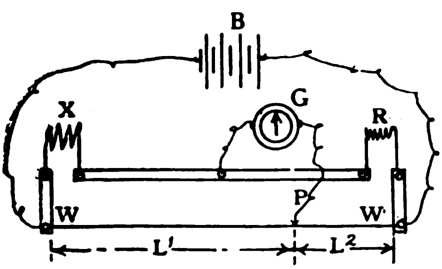


Fig. 2. Measuring Resistance by Slide Wire Bridge

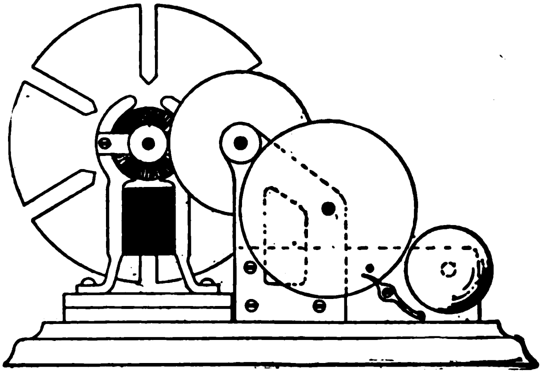


Fig. 3. Auxiliary Speed Counter

In the case of small dynamos, where the field winding is not on a detachable bobbin, but is wound directly on to the core, it is advisable, whenever sending a current through it, as in the conductivity test, to make the connections so that the magnetism caused by the current will be of the correct polarity. The commutator should also be tested with the battery and galvanometer to prove that the segments do not make contact with each other. When the armature is finished, and each section has been tested, the total resistance should be measured. If the brushes are clean and making good contact with the commutator, their resistance will be practically nothing, so the armature resistance may be measured from brush to brush by means of a Wheatstone Bridge, or by using a galvanometer. The resistance of the field should also be measured. Fig. 2 shows how to find the resistance by means of a slide wire bridge. *R* is a known resistance, *X* the unknown.

The end of wire P is moved along the slide wire WW until there is no deflection of the needle, when the resistance

$$X = \frac{L^1}{L^2} R$$

The first step in testing a finished machine is to see that it is firmly screwed down, that the bearings are oiled, the belt even and not too tight, the brushes making good contact, and that all electrical connections are well made. The field magnets should be tested with a magnetic needle to see that they have the correct polarity, or at least that they are not both the same. If it is found that the poles are of like polarity, the field magnet should be remagnetized correctly by means of a powerful battery.

A test card should be made out on which the type of machine, date of test,

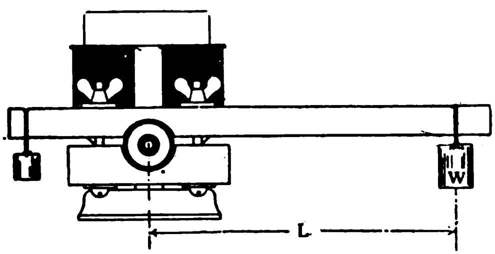


Fig. 4. A Simple Wooden Brake

speed, volts, amperes, etc., and all conditions and results obtained should be recorded.

In testing a dynamo some arrangement must be made for absorbing the current generated, such as an adjustable wire or liquid resistance. Wire is to be preferred, as, owing to electrolysis, small liquid resistances are inconstant and are difficult to adjust. A voltmeter should be connected across the brushes and an ampere-meter in series with the resistance. A starting switch should be provided, and the machine run up to speed before closing the circuit. The resistance is then regulated until the meters show that it is working at full load. It

altered. The brushes should have a forward lead with a dynamo, backward with a motor. Sparking at the commutator may be due to many causes, such as wrong connections or short circuits in the armature, rough commutator, brushes in the wrong place, or too great a load. The armatures of many small machines will cause a certain amount of sparking because of the difficulty in getting each section wound with an equal amount of wire. Overheating of the windings is usually caused by overloading the machine.

With small shunt machines it is not usually possible to regulate the current in the field winding. It is, however, an interesting experiment to excite the field winding with an independent current by means of the battery, and see the effect of running the armature with various field strengths and at various speeds. If the air-gap of a dynamo is large, this experiment will show if any improvement could be made by altering the field winding.

TESTING FOR HORSE-POWER AND EFFICIENCY

The amount of power that a machine develops, can, in the case of a dynamo, be read in watts from the volt- and ampere-meters (watts = volts x amperes); in the case of a motor determined by means of a prony brake. The efficiency of a machine is the ratio of the power produced to the power consumed.

To take the case of a dynamo first. The efficiency equals the electrical output divided by the mechanical input, both powers expressed in watts. For example, 1 h.p. = 746 watts. So in a case where a dynamo takes 1-6 h.p., to make it generate 60 watts the efficiency would be

$$\frac{60}{1\text{-}6 \times 746} = .48, \text{ that is, 48 per cent.}$$

To read the electrical output of a dynamo is easy enough, but, unless it is

electrical and mechanical. The chief electrical losses are due to the resistance in the armature and in the field-windings. These resistances should be measured, as has already been described, while the machine is hot—just after running. Having found these resistances, the watts lost in each way may be determined thus: Let the total loss in the armature and field winding be expressed in watts = W.

In a series machine $W = C^2 (R_a + R_f)$.

In a shunt machine $W = C^2_a R_a + C^2_f R_f$. In these formulas R_a = the resistance of the armature.

R_f = the resistance of the field.

C = the total current.

C_f = the current in the field = $\dfrac{\text{voltage}}{R_f}$

C_a = the current in the armature $= C—C_f$.

It has been found by experiment that all other losses in most small machines can be fairly well accounted for by reckoning them as equal to 25 per cent. of the total output. So we now get the input by adding the watts lost in the field and armature plus 25 per cent. of the output plus the total output. Another way of finding the input would be to make careful note of the exact conditions, pressure, speed, etc., under which the driving engine is running when working the dynamo, and then to replace the dynamo with a prony brake and adjust it until the engine is running under those same conditions again. A more direct method would be by means of a transmission dynamometer. There is another direct way which is particularly suitable for small dynamos, namely, the balance method, as described at the end of this article.

In the case of the motor the input is electrical and the output mechanical. This time it is the input that can be read from the volt- and ampere-meters. The output or horse-power is measured by means of a prony brake, and a speed recorder or some arrangement of gearing to enable the revolutions per minute to be counted by sight. With a dynamo the speed can be calculated from that of the driving engine, allowing 5 per cent. for belt slip. Sometimes, with very small machines, it is difficult to find the speed by these methods. In such cases an auxiliary motor may be used, the speed of which is shown by a counter or by gearing. This motor has a disc with slots cut radially in it mounted on its shaft. Another disc, the same size, with the same number of slots, is mounted on the shaft of the machine being tested. The two machines are placed in line, and the speed of the auxiliary one regulated until both discs appear to be standing still. The speeds of both machines are then alike. Fig. 3 is an illustration of a toy motor rigged up as an auxiliary speed counter. Almost any cheap little motor supplied with current from the battery

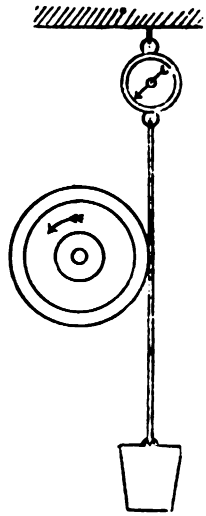


Fig. 5

will do for this. An adjustable wire resistance must be provided in order to regulate the speed. The slotted disc—which may be made of cardboard—can be put on to the same end of the shaft as is the gearing. The sizes of the gear wheels in number of teeth are—fifteen on the armature shaft, seventy-five and fifteen on the intermediate, and ninety on the countershaft. Any wheels having about the same ratio would do. The last wheel has a small pin inserted in one side, which rings the bell for every thirty revolutions of the armature shaft. Two simple prony brakes are illustrated here. The one shown in Fig. 4 consists of two wooden blocks, which are clamped on to the motor pulley by means of two bolts. The small weight on the left is to counterbalance the longer arm, and should be adjusted until the brake is

perfectly balanced on the pulley. This is most important. When the perfect balance is obtained, the two bolts must be tightened until the brake begins to clamp the pulley. When the pulley revolves and the nuts are tightened, a weight, W, must be added. This weight is increased in order to keep the brake balanced horizontally. The pulley should be well lubricated with grease or soap. The horse-power = .0001904 times the revolutions per minute, times the distance L in feet, times the weight W in pounds. Fig. 5 shows another type, using a spring balance. The weight may consist of shot or sand. W is the direct reading of the spring balance. With this type the horse-power =

$$\frac{2\pi r(\text{r.p.m.})}{33{,}000} \times W.$$

The torque of a motor is its turning effort. It is equal to the belt pull in pounds multiplied by the pulley radius in feet.

$$\text{Torque in ft.-lbs.} = \frac{H.P.}{(\text{r.p.m.})\ .00019}$$

It may be measured directly by means of the prony brake, by first loading the arm with a weight and clamping the brake on to the pulley fairly tightly, then gradually increasing the current supply to the motor until the pulley just begins to turn.

The efficiency of a motor is found by dividing the power developed, expressed in watts, by the number of watts that it is consuming.

An interesting method for measuring the power absorbed by a small machine is that in which the magnetic field is used as the brake. The machine to be tested is put between centers—in the lathe, for example, a center in each end of the armature shaft. The frame of the machine now has to be balanced with weights, as in the prony brake. The best way to do this is to fasten a bar of wood on to the top of the frame, on

in his particular case are worth while making, such as, in the case of a shunt motor, the overload capacity or the speed variation—that is, the difference in speed between no load and full load. A series-wound motor should never be allowed to run at full speed when unloaded.

The additional interest that a model provides to its owner when he thoroughly understands it well repays the trouble taken in carrying out these simple tests.—*The Model Engineer and Electrician.*

Final Test of New Wireless Station

The final test of the new wireless station of the Navy Department at Arlington, which is still in the hands of the contractors, was made last month when an effort was made to exchange messages between the station and the scout cruiser *Salem* at a distance of 3,000 miles. Orders had been issued by the Navy Department for the *Salem* to fill up her crew so as to be in readiness for the test on January 15. She then put across the Atlantic, and in making the tests described a circle, the radius of which was 3,000 miles, the distance called for in the Government contract. The *Salem*, with as powerful wireless apparatus as any in the Navy, proved able to respond to any message flashed from the giant towers across the Potomac. The tests at the new Arlington station have been very satisfactory. While few of these have been at full capacity, the station at the Mare Island Navy Yard, Vallejo, Cal., had been reached, and frequent communication has been had with Colon, a distance of 2,000 miles. The station will be shut down in a week to allow the installation of a new spark-gap.

Huge Electric Clock

To advertise the Boston Edison Company, a large electric sign has been set up in that city, measuring over all 54 ft. in width by 60½ ft. in height. The sign contains a clock, with the dial 34 ft. in

DESIGN FOR A PORTABLE DRAWING FRAME

W. B.

Suffering from the baneful effects of working at a table, I had often thought that I should find a frame advantageous and also convenient. I do not wish it to be understood that mine is *the* original idea, but I have a thought that for convenience, rigidity, and portability it will compare with any I have hitherto seen.

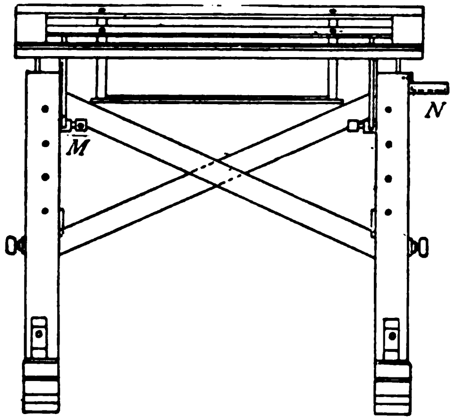


Fig. 1

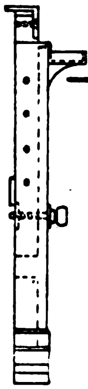


Fig. 3

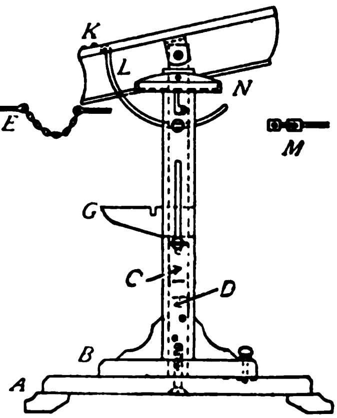


Fig 2

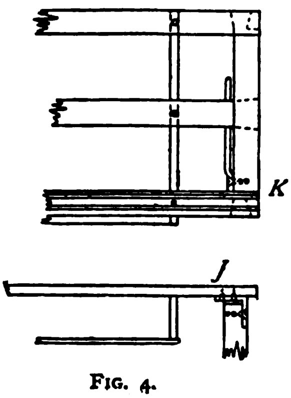


Fig. 4.

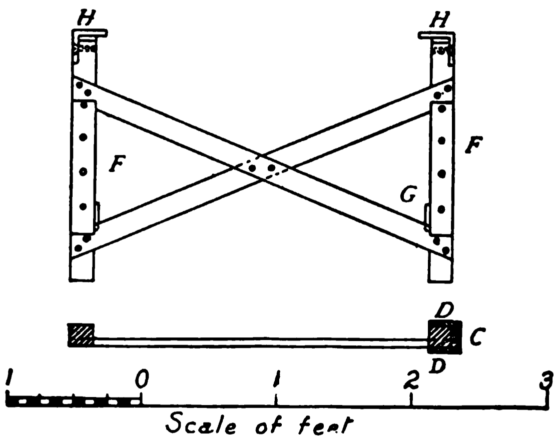


Fig. 5.

Design for a Portable Drawing Frame

How many draughtsmen would be glad to be able to work in their own sitting-room, and, when work is done, take off the drawing-board, fold down the top frame, swing round the wide feet to the span of the feet at the base of the frame standards, lay their square on the brackets and instrument on the square, push all back into a convenient corner, drop a light baize cover over all, sit down, and have an hour with a fellow-amateur? This is what I did several years since, and I do not regret the dollar and a half spent for material and the time occupied in the making.

Before I describe the drawings, I should like to say there is ample space and provision for a foot rail, if desired; but I prefer it as it is. This frame is perfectly free from the least vibration, even under strain.

Fig. 1 gives the front elevation of frame as set for a man about 5 ft. 8 in. in height. The drawing-board simply lies upon the framed top, and can be shifted to any position to suit the light

and convenience of the draughtsman. This is a great convenience, especially where one's sight is failing.

Fig. 2 shows an end elevation; Fig. 3 a line view of one of the standards; Fig. 4 a plan and front view of the framed top and open shelf underneath (now shown 4 in. clear, but mine is only 3 in. clear). Fig. 5 is the braced sliding frame and the plan of same, and on the right hand the sliding case is shown in section; the bracing is as seen from the back.

CONSTRUCTION

To those who will afford it, the whole of the wood used should be kauri for the frame and yellow pine for the top and shelf. But where economy has to be studied, even white deal will do. But the whole should be carefully and truly wrought. *A*, Fig. 2, are bases with claws glued and screwed on and prepared for the swivelling screw, which should be 4 in. and stout. These bases will be swung round when the frame is not in use. *B*, Fig. 2, are the feet of the standards, into which are tenoned the lower pieces of 2 x 2 in., as shown by dotted lines. *C* is the stoutest portion of the sliding case, and, as shown, is glued and screwed to the 2 x 2 in. *DD* are the back and front portions of the slide case, and these are screwed to *C* and also to the 2 x 2 in. The slot shown in *C* is for the thumb-screw, as shown, which, with its brass nut, is let into the 2 x 2 in. front slides for clamping. Shown on *D*, Fig. 2, are four holes, into which the pin *E* passes, and through one or more holes in the 2 x 2 in. *FF* (to choice). These pins take up the dead weight and relieve the thumb-screws. Fix—where shown at *B*—carefully squared angle-blocks, also glued and screwed. There is shown at *B* thumb-screws, passing through and screwed into a flush-nut in *A*.

Fix at *G* on the slides, Fig. 5, 3/8 in. brackets, as shown, with a gap in same so that the back edge of the blade of the square may rest in same when not in use.

The carefully braced frame, Fig. 5, should have if possible, hard wood 2 x 2 in. slides at *FF*, braced as shown. *HH* are two pieces of coach hooping, carefully forged with a sharp internal angle, each into slides at *HH*, and made with lower end curved, and fixed with a well-fitted pivot-screw to slide *FF*, but not too tight.

Form the shelf, Figs. 1, 2, and 4, by screwing through the top frame, as shown, into the checks and nailing the bottom to the checks. All the edges of the bottom to be rounded; the back and front ends of checks to be cut to form, as shown. The reason for the edge next the draughtsman projecting is to give him a quicker touch of his various instruments. It is as well to fix on the bottom a beveled strip to prevent slipping. Fix—where shown at K, Fig.2 — two fillets 3/8 x 1/4 in., the upper one to form stop for drawing-board, and the lower one forms a channel for instruments. The edge of top frame next the draughtsman should be eased away, as shown, for comfort of touch.

At *K*, Figs. 1 and 2, are stays made of 1/4 in. soft steel, neatly bent at upper end so as to receive a screw, and fixed, not too tightly, to the inside edge of top frame. (This part of top frame to be 3 1/2 in. wide). The remaining portion of the stays are to be neatly bent to a radius of about 6 in. from the center of the pivot-screw. Screw guide-eyes *M*, also shown on Fig. 1, and set screws are fitted in the heads of *M* to pinch the stays *L*. The zinc tray *N*, Figs. 1 and 2, is very easily made, and is convenient for instruments and for color platters.—*The Model Engineer and Electrician.*

Sulphated Accumulator Plates

H. C. ROBSON

The following may be of some use to your readers. Having an accumulator to clean that was badly sulphated, I set to work to clean it in the following way: Get about 1/2 lb. of ammonium acetate, dissolve in 1 qt. of water and put in earthenware jar and immerse the lead plates and allow them to stay for half an hour, keeping them hot during this while. The plates will now be free from the sulphate, wash and dry, and they can now be replaced in the accumulator case. In this method the plates need not be detached, thus saving a great deal

INFORMATION FOR SHIPS DESIRING TO FORWARD RADIOGRAMS THROUGH U.S. NAVAL RADIO STATIONS

1. The charges to be collected on board ship consist of:

(*a*) The ship charge.

(*b*) The coast station charge.

(*c*) The charges for land line or cable transmission.

(*a*) Is fixed by the company operating the radio set on board ship. (*b*) Is fixed by the Secretary of the Navy for naval radio stations. (*c*) Is fixed by the Secretary of War for Alaskan telegraph lines and cables and by the telegraph and cable companies in the United States.

2. Each ship should have on board tariff sheets showing the charges for each station open to general public business and the telegraph and cable rates from each station to any point in Alaska, the United States, or Canada, and as far as possible to any part of the world. However, should the ship not be provided with these rates, they may obtain them by means of a service message to a coast station. Call the station and send the interrogation signal twice, followed by: "——rate to——." Naval stations will be prepared to furnish rates by cable to foreign countries; also the radio rate through any foreign coast station open to general public business, and the ship rate of any ship whose name is to be found in the international list of radio stations.

3. The charge for a radiogram must in every case be paid in full by the sender. A receipt for charges prepaid should be demanded and retained by the sender for possible future inquiries. A sender may designate the coast station to which he desires his radiogram to be sent. The operator will then wait until that station is the nearest; if no station is designated the message must be sent to the nearest coast station. In case there are alternative routes for the transmission of a message beyond the coast station, the sender should designate the route. In the United States, he should state whether the radiogram is to be forwarded by the Western Union or Postal Telegraph Companies. In routing the message the letters "W" and "P" should be used to designate these companies respectively.

PRIORITY OF MESSAGES

4. Ordinarily the business between the ship and coast station should be carried on in the following order:

(*a*) Messages relating to the navigation of the ship.

(*b*) Service messages relating to the conduct of the radio service, or to previous radiograms transmitted by the stations concerned.

(*c*) Commercial messages.

5. Messages of the same rank will be transmitted in the order in which they were handed in. The coast station will direct whether the ship and station are to send messages in alternate order or in series of several messages. The time occupied by a series of messages may not exceed 12 minutes.

NUMBERING OF MESSAGES

6. Messages for certain coast stations should be numbered in sequence, beginning with one, each station to have a separate series of numbers. A new series should commence with midnight each day.

CODE

7. The International Morse Code only will be used by naval stations.

SHIP TO CALL COAST STATION

8. As a general rule, the ship calls the coast station when its distance is less than 75 per cent. of the normal range of the coast station, as given in the international list. Before beginning to call, the ship operator should adjust the receiver for the calling wave-length of the coast station and his detector for maximum sensitiveness, after which he should listen in to see if the station he wishes to call is not engaged. If he finds that the station is working with another ship or station, the operator must wait for the first break before calling. Too much care cannot be taken in carrying out these regulations, as by calling a station already busy an operator is liable to interfere and cause delay, not only for his own message, but for any others that may be in progress. On the request of the coast station, a ship will immediately cease calling, and the station will then indicate,

approximately, the time it will be necessary to wait.

COAST STATION THE CONTROLLING STATION

9. Operators should remember that the coast station controls all communications in its neighborhood, in which it is guided solely by the desire to handle as much work as possible. When a coast station receives calls from several ships, it shall decide the order in which the ships shall be received in order that each ship may be allowed to exchange the greatest possible number of messages before going out of range. Preference is therefore given to the ship whose position, course, and speed indicate that she will be the first to pass out of range.

FAILURE TO REPLY

10. No reply having been received to a call repeated three times at intervals of two minutes, a call should not be renewed until after an interval of 20 minutes, and then only if no communications are going on which will be interfered with.

PROCEDURE WHEN SIGNALS BECOME DOUBTFUL

11. When signals become doubtful, a message will be repeated at the request of the receiving station three times only. Should the signals be unreadable in spite of being thrice repeated, the message will be canceled. If an acknowledgment of receipt is not received, the ship again calls the station. If no reply is made after three calls, they shall not be continued. Should the station think that the message may be delivered, it acknowledges receipt, inserts the service instruction, "reception doubtful," at the end of the preamble, and sends on the message.

SUPERFLUOUS SIGNALS

12. Every effort should be made to cut down the number of superfluous

Calls

5. A call shall be preceded by the ATTENTION signal

— • — • —

The call of the station shall be made three times and separated from that of the calling station, also repeated three times, by

— •• • (DE)

6. The signal

— • — • — — • — (CQ)

shall be known as the INQUIRY signal, to be used for calling any ship or station which may be within range, when its name is not known. It shall be preceded by the ATTENTION signal,

— • — • —

followed by

— •• • (DE)

and the call of the inquiring ship or station repeated three times.

7. A station called shall reply by giving the ATTENTION signal,

— • — • —

followed by the call of the calling station repeated three times, the signal

— •• • (DE)

her own call repeated three times, and the GO AHEAD signal

— • — (K)

The use of GA or G shall be discontinued.

8. If a station called does not answer the call repeated three times at intervals of two minutes, the call shall not be resumed until after an interval of 15 minutes, the station making the call having first made sure that no communications are being interfered with.

9. When a station is called by several ships it shall decide the order in which it will work with them. In general, a station controls all radio communications within its range as far as commercial work is concerned.

Examples

(1) Ship KSA calls NAN thus:

— • — • —

(2) KSA sees a ship on the horizon, or, having nothing in sight, wishes to inquire if there is any ship or station within range:

—•—•— (ATTENTION signal)
—•—• ——•— (INQUIRY signal)
—•• • (DE)
KSA KSA KSA

NJS answers:

—•—•—
KSA KSA KSA
—•• •
NJS NJS NJS
—•—

Position Reports

10. A position report shall be preceded by the letters TR and shall be made as follows:

(*a*) The approximate distance, in nautical miles, of the vessel from the coast station;

(*b*) The position of the ship given in a concise form and adapted to the circumstances of the individual case;

(*c*) The next port at which the ship will touch;

(*d*) The number of messages, if they are of normal length, or the number of words if the messages are of exceptional length.

The speed of the ship in nautical miles shall be given specially at the express request of the coast station.

Commercial ships may be expected to use the form required by the Berlin Convention. (See examples, (2) page 4.)

12. Special care shall be taken not to interrupt the business of the station, which may be receiving signals at the time that cannot be received on board ship on account of the lower aerial; the ship shall, therefore, cease calling promptly on demand.

13. The signals

•—••• (WAIT),

and QRM, QRW, QRX and QRY (see par. 73) shall be used to cover cases of interference.

Examples

(1) After station acknowledges ship's call, ending with

—•—

the ship sends: TR, 50 (nautical miles).
Off Cape Fear
Havana
4 (number of messages)

(2) A commercial vessel, especially if foreign, may be expected to send:
50 (distance)
93 (bearing from station)
184 (course)
9 (speed)
40 (number of words)

The numbers may be separated by the BREAK sign or the signals QRB, etc. (par. 73), may be used.

Transmission of Radiograms

16. The station, after acknowledging the position report, shall reply, giving either the number of words or the number of messages to be sent to the ship and the order of transmission, if the station is ready to send or receive at once; if not, the station shall inform the ship of the approximate length of the wait.

17. In case the ship is not ready to receive for the moment, she shall inform the calling station of the approximate length of the wait.

18. The object aimed at must always be the handling of the greatest amount of business before ships get out of range.

19. Before beginning an exchange of messages the station shall inform the ship whether the messages shall be sent in alternate order or by series of so many messages, in case there are several to be sent each way. The abbreviations given later (par. 73) may be used to indicate the order, or the word "series," if there are less than five messages.

20. The transmission of every message shall be preceded by the ATTENTION signal.

21. When a message to be sent contains more than 40 words, the sending ship or station shall interrupt the transmission after each series of about 20 words with an interrogation

••——••

and shall not continue until the receiving station repeats the last word received and

—•—

The Preamble

22. The preamble consists of all the items sent before the address. It follows the ATTENTION signal

—•—•—

and is separated from the address by the BREAK or DOUBLE DASH

—•••—

Numbering of Messages

24. Each message, regardless of class, sent by a ship or station, will be numbered in sequence, the first message of each day sent to a certain ship, station, or land line office, to be numbered 1. Each ship or station will have a separate series of numbers for each station or land line office to which it transmits, a new series to begin each day at midnight.

25. The receiving number is that given by the ship, station, or office received from, and will not be transmitted, but a new number will be assigned, in case the message is retransmitted, and will be the next number in sequence for the station sent to. The number will be transmitted as the second item of the preamble of the message (following the abbreviation "Ofm," "Svc," or "Msg"), without the abbreviation "No" or "Nr." In receiving a series of messages the sequence of the receiving numbers will be noted, and in case a break in the sequence should occur, inquiry for the missing message shall be made immediately.

Examples

(1) The first ten messages received at a station on a certain day are from the S.S. *Amazon*. They should be numbered 1–10 by the *Amazon*. The next two messages are from the *Reid*, numbered 1 and 2 by the *Reid*.

(2) The next messages from the *Reid* are sent to the *Louisiana* direct. They should also be numbered 1 and 2 by the *Reid*.

(3) All of the messages received by the station from the *Amazon* and the *Reid* are turned over to a land line or cable office for further transmission with the numbers 1–14, being the first messages sent that day through that office.

Station Call

26. The station call shall follow the number. The sending operator's sign shall not be transmitted, but shall be recorded on the message blank. No operator shall change his personal sign without the authority of the electrician in charge of the station, or the radio or signal officer on board ship. No two operators at a station or on board a ship shall use the same sign.

The Check

27. The check shall consist only of the number of words, including the address and signature, with the exceptions noted in the following paragraph and under the heading "Counting of words" (par. 68). The number or numbers only shall be sent without the indication "Ck."

Dating

29. After the check, the ship, station, or office of origin shall be sent, except by the originating station itself, followed by the original date should the message not be forwarded or delivered on the original date. The *name* of the original ship, station, or office shall always be sent in order to avoid errors on account of similarity of call letters. A message forwarded over a land line by a coast station shall show its own name as office of origin, followed by that of the ship.

30. On board ship and at stations which receive messages from the public direct, the time when a message is filed—*i.e.*, handed in for transmission—shall be noted on the sending blank. This time shall be known as the "time of filing."

35. For a message to be forwarded by land wire or cable, the particular line or cable shall also be indicated after indicating the ships and station handling it by radio. For land lines in the United States, use "W" for Western Union Telegraph Co., "P" for Postal Telegraph Co.

The Address

36. The address must consist of at least two words. Telegraph companies will register radio addresses at all offices without charge. The cable addresses prescribed by Navy Regulations shall be used for radiograms.

Body of Message

37. The message and signature, if any, must be sent exactly as received. The address, message and signature must be sent with special care, the sending operator regulating his speed to suit the ability of the receiving operator, avoiding a jerky style of sending. Slow steady sending at the rate of about 20 words per minute will give best results. Messages containing code words or cipher should be sent more slowly than those entirely in plain language. Government

messages containing code words and cipher shall be immediately repeated back by the receiving station, with the following exceptions:

(1) In repeating a message of more than 10 words, containing few code words or cipher groups, the code words or cipher groups only shall be repeated.

(2) Weather reports and other reports made up of code words with which operators may become familiar from frequent use need not be repeated. Should the receiving operator have any doubt about one or more words, he should repeat and get

•••-• (UNDERSTOOD)

from the sending operator.

Signature

38. The indication "Sig" before a signature shall not be transmitted. No signature is required for any except official messages. In case a message is not signed, no mention of the fact shall be made, as the check will be a sufficient indication.

End of Message

The message is ended by the END OF MESSAGE signal, the cross (+) of the International Morse code,

•-•-•

followed by the station call.

Example

Order of transmission of a radiogram after receiving the signal "K" (go ahead). ("Prairie" sending to Key West.)

1. -•-•- *Attention* signal.[1]
2. OFM (or) SVC (or) MSG — Government message, or service message, or commercial or private message.
3. 5 — Number.
4. NQM — Station call.
5. 5 — Check—number of words.
6. USS. *Wyoming*—Originating station.
7. 12 — Original date, if other than date of transmission.
8. Via NAR W Route.
9. -•••- *Double dash* or *break* (end of preamble).
10. Larrimer New York — Registered radio address.
11. -•••- *Double dash or break.*

by the word before that sent incorrectly or before a word omitted.

Example

"Arrive ten tonight, stay in waters indefinite

••••••••

in these waters indefinite."

Repeating

40. In addition to its uses as an interrogation, the signal

••--••

shall be known as the REPEAT signal, and shall be used to obtain a repetition of messages or words as follows:

1. To have a single message entirely repeated, send, (*a*), call of station sending message, (*b*), the REPEAT signal three times, (*c*), station call.

2. To have one of a series of messages repeated, send, (*a*), call of station sending message, (*b*), number of message, (*c*), the REPEAT signal three times, (*d*), station call.

3. In case the first part of the message is received satisfactorily, indicate the last word received and get a repetition of the last part of the message by sending (*a*), call of station sending message (*b*), number of message, if necessary, (*c*), last word received, (*d*), REPEAT signal, (*e*), station call. This will be taken to mean "Repeat after——."

4. In case the last part of the message was received satisfactorily, indicate the first word of the part received and get a repetition of the message as far as that word by sending, (*a*), call of station sending message: (*b*), number of message, if necessary; (*c*), the REPEAT signal; (*d*), first word of part received; (*e*), station call. This will be taken to mean, "Repeat as far as——."

5. To get a repetition of one or more lost or doubtful words, send, (*a*), call of station sending message; (*b*), number of message, if necessary; (*c*), word received just before lost or doubtful word or

(2) NAM
6
••——••
••——••
••——••
NAL
(Repeat your No. 6.)
(3) NPC
1
Report
••——••
NPD
(Repeat after word "Report.")
(4) NPO
••——••
Nicholson.
NPT
(Repeat as far as "Nicholson.")
(5) NLC
4
Several
••——••
Instruct.
NAO

"Received" Signal

41. To acknowledge a single message or series, send:

(1) The RECEIVED signal, R.
(2) Number of message, or numbers of first and last messages of a series.
(3) Ship or station call.
(4) Operator's sign.
(5) The GO AHEAD signal if ready to receive another message; the ATTENTION signal, preamble, etc., if a message is to be sent; or the FINISHED signal,

•••—•—

followed by ship or station call if all business is cleared, which shall be answered by the other ship or station in the same manner.

Examples

(1) •—• (RECEIVED).
4
NPC
XP
(2) •—•
1
5
NJC
GL
(3) •—•
11
15
NAX
V
•••—•—
NAX

NAR answers:
•••— —
NAR

Language

42. A radiogram may be sent in plain language, code language, or cipher:

(1) Radiograms in plain language are those composed of words, figures, and letters which offer an intelligible meaning in any of the European languages. The words and letters must be written in Roman characters. In case of unfamiliarity with the language being sent, the sending operator's statement that a message is in "plain language" shall be accepted.

(2) Code language is composed of real words not forming intelligible phrases or of artificial words consisting of pronounceable groups or letters, such as words in which the letters are alternately consonants and vowels. No code word, whether real or artificial, may exceed ten letters in length. The real words may be drawn from any of the following languages: English, French, German, Italian, Spanish, Portuguese, and Latin. The artificial words must be formed of syllables which must be pronounceable according to the current usages of one of those languages. Combinations formed by running together two or more real words, whole or contracted, or a real word and some other expression are prohibited.

(3) Cipher is composed of:

(*a*) Arabic figures or groups, or series of Arabic figures having a secret meaning, or letters or groups, or a series of letters having a secret meaning.

(*b*) Combinations of letters not fulfilling the conditions applicable to plain language or code.

Letter and figure cipher cannot be combined in one group.

Counting of Words

44. The word system of counting shall be observed, and all words in the address, text, and signature must be counted and charged for.

Abbreviations

73. The following abbreviated signals will go into effect with the London Convention, July 1, 1913, and will be used by ships of all nations which may ratify that convention. They shall be used between stations and, wherever practicable, with commercial ships that are familiar with them, after receipt of these instructions:

—•—• ——•— (CQ)

Signal of *inquiry* made by station desiring to communicate.

— ·—· (TR)
Signal preceding position report; or "Send position report."

——··—— (!)
Signal indicating that a station is about to send at high power.

Abbreviation	Question	Answer or Notice
PRB	Do you wish to communicate by means of the International Signal Code?	I wish to communicate by means of the International Signal Code.
QRA	What ship or coast station is that?	This is ——.
QRB	What is your distance?	My distance is ——.
QRC	What is your true bearing?	My true bearing is —— degrees.
QRD	Where are you bound for?	I am bound for ——.
QRF	Where are you bound from?	I am bound from ——.
QRG	What line do you belong to?	I belong to the —— Line.
QRH	What is your wave-length in meters?	My wave-length is —— meters.
QRI	How many words have you to send?	I have —— words to send.
QRK	How do you receive me?	I am receiving well.
QRL	Are you receiving badly? Shall I send 20 ···—· for adjustment?	I am receiving badly. Please send 20 ···—· for adjustment.
QRM	Are you being interfered with?	I am being interfered with.
QRN	Have you much static?	There is much static.
QRO	Shall I increase power?	Increase power.
QRP	Shall I decrease power?	Decrease power.
QRQ	Shall I send faster?	Send faster.
QRS	Shall I send slower?	Send slower.
QRT	Shall I stop sending?	Stop sending.
QRU	Have you anything for me?	I have nothing for you.
QRV	Are you ready?	I am ready. All right now.
QRW	Are you busy?	I am busy (or: I am busy with ——). Please do not interfere.
QRX	Shall I stand by?	Stand by. I will call you when required.
QRY	When will be my turn?	Your turn will be No. ——.
QRZ	Are my signals weak?	Your signals are weak.
QSA	Are my signals strong?	Your signals are strong.
QSB	Is my tone bad?	Your tone is bad.
	Is my spark bad?	Your spark is bad.
QSC	Is my spacing bad?	Your spacing is bad.
QSD	What is your time?	My time is ——.
QSF	Is transmission to be in alternate order or in series?	Transmission will be in alternate order.
QSG		Transmission will be in series of 5 messages.
QSH		Transmission will be in series of 10 messages.
QSJ	What rate shall I collect for ——?	Collect —— for ——.
QSK	Is the last radiogram canceled?	The last radiogram is canceled.
QSL	Did you get my receipt?	Please acknowledge.
QSM	What is your true course?	My true course is —— degrees.
QSN	Are you in communication with land?	I am not in communication with land.
QSO	Are you in communication with any ship or station (or, with ——)?	I am in communication with —— (through ——).
QSP	Shall I inform —— that you are calling him?	Inform —— that I am calling him.
QSQ	Is —— calling me?	You are being called by ——.
QSR	Will you forward the radiogram?	I will forward the radiogram.
QST	Have you received the general call?	General call to all stations.
QSU	Please call me when you have finished (or) at —— o'clock.	Will call when I have finished.
QSV	Is public correspondence[1] being handled?	Public correspondence[1] is being handled. Please do not interfere.
QSW	Shall I increase my spark frequency?	Increase your spark frequency.
QSY	Shall I send on a wave-length of —— meters?	Let us change to the wave-length of —— meters.
QSX	Shall I decrease my spark frequency?	Decrease your spark frequency.

[1]Public correspondence is any radio work handled on the commercial tunes 300 or 600.

Additional abbreviation proposed for international use, and authorized for naval stations:

Abbreviation	Question	Answer or Notice
QSZ	....	Send each word twice. I have difficulty in receiving you.

When an abbreviation is followed by a mark of interrogation, it refers to the question indicated for that abbreviation.

Examples

Station A. QRA? = What is the name of your ship or station?
Station B. QRA *Celtic* MLC = This is the *Celtic*. Her call is MLC
Station A. QRG? = To what line do you belong?
Station B. QRG *White Star* = I belong to the *White Star* line.
QRZ = Your signals are weak.
Station A then increases the power of its transmitter and sends:
Station A. QRK? = How are you receiving?
Station B. QRK = I am receiving well.
QRB 80 = My distance is 80 nautical miles.
QRC 62 = My true bearing is 62 degrees, etc.

CONDENSER TUBES

A number of interesting papers have been presented before the British Institute of Metals, among which should be particularly mentioned, "The Corrosion of Brass Condenser Tubes," by Mr. Paul T. Bruhl. This paper is the result of a thorough study of this troublesome problem and brings out certain very interesting conclusions arrived at by the author. "In this connecton, attention should be called," says Carl F. Woods, of the staff of Arthur D. Little, Inc., chemists and engineers of Boston, "to the proceedings and the report of the corrosion committee of the Institute which was opened a year ago with a view to carrying out an exhaustive and authentic research on the corrosion of brass and bronze. The committee have decided to erect in Liverpool a plant in which the conditions of marine condenser service should be as closely imitated as possible. The plant is to consist essentially of four cast iron tubes, each fitted with tube plates to carry 12 condenser tubes, these iron tubes representing four small independent condensers. The condensers will be connected direct to the exhaust of a small engine which in turn will drive a circulating and vacuum pump for circulating sea water through the condensers. Each condenser will be fitted with the same kind of tubes, and the committee has decided for the first set that one condenser shall be equipped with the so-called 'Admiralty' mixture with a tube plate of naval brass, the equipment being carried out with the same extreme care insisted upon by the 'Admiralty' practice. The second condenser will represent the best class of commercial practice, the tubes being 70-30 mixture and the plates of yellow metal. The exact equipment of the other two condensers had not been decided upon at the time of the committee's progress report, but they will be compositions representative of commercial practice. The results obtained from careful experiments carried out in this way should be of the utmost value as it should be possible to practically duplicate service conditions and at the same time to control the various conflicting conditions in such a way as to arrive at definite well-founded conclusions."

Electric Vulcanizer for Automobile Tires

J. C. MUNN

An electrically-heated vulcanizer for either the inner tube or the casing of automobile or motorcycle tires has been recently placed on the market. The vulcanizer consists of an electrically heated vulcanizing clamp for holding the tire in position and a small rheostat for regulating the amount of current. Tire repairs can be made in the minimum of time and with very little expense. The work can be done by anyone and there is no danger of injuring the tire.

HOME-MADE ELECTRIC CHANDELIER

A. C. GOUGH, M.E.

The massive brass fixtures, finished in various effects, harmonize splendidly with the other furnishings of the popular arts crafts room. The more delicate and intricate designs of fixtures lending themselves better to the room furnished with Colonial, Louis XIV and Rococo designs of furniture. Perhaps, the modern, plain massive brass fixture is the most acceptable of all for the arts crafts room; but designs in wood offer possibilities, in appearance as well as in the low cost of making, for those who wish to make their own fixtures.

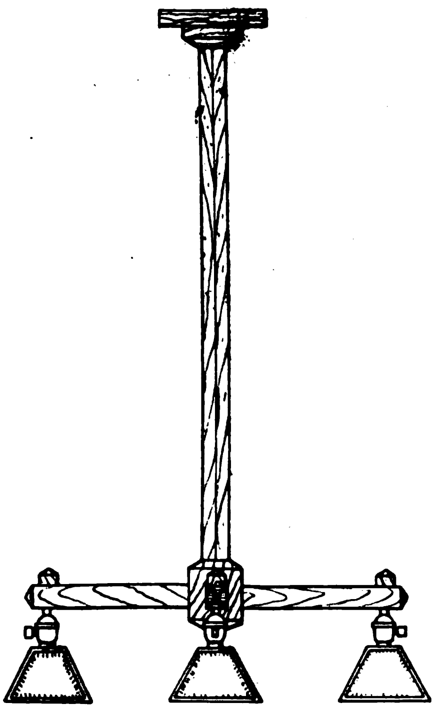


FIG. 1

Where the boards, casings, moldings, etc., of a room are finished in oak or dark wood, the wood chandelier may be finished to match. Or when a room is finished in white, the fixture may be coated with a white enamel. Another effect which lends itself to the largest variety of color schemes is, to first gild the fixture, then (after it is dry) wipe it with burnt umber. This may be easily done in a way that will produce an effect of age which is really artistic and lasting.

That the possibilities of designs in wood have not been sought is probably due to the fact that underwriters do not favor conduits constructed of wood. However, with a building constructed of wood, it might seem rather difficult to wire it without passing the wires through the wooden walls, etc. In this case, the underwriters require that the already heavily insulated wires have an independent casing of circular loom or porcelain supported within the hole through which the wire passes. While it is not nearly so important that the chandelier be wired with such precaution for safety, but that the wiring may not be questioned by the insurance companies, circular loom of good size and strength may be used to cover the wires throughout. If good size rubber-covered or weather-proof wire is used it is not at all necessary; but it may be most desirable to use independent pieces of circular loom upon each of the branch wires which extend to the sockets, with two larger pieces of circular loom within the vertical part, each containing the wire, or wires, forming one side of the circuit. However, with rubber-covered or weather-proofed wire, it is more than safe to use one piece of circular loom for the branches with a large piece of circular loom covering the wires through the vertical part.

The following tables give the values of currents allowed by underwriters in wires of various sizes:

	TABLE 1 *Rubber-covered Wires*	TABLE 2 *Weather-proofed Wires*
B.&S. Gauge	Amperes	Amperes
No. 18	3	5
No. 16	6	8
No. 14	12	16
No. 12	17	23
No. 10	24	32

A large incandescent lamp does not usually require more than 1 ampere; so No. 18 or No. 16 wire would have a current-carrying capacity much larger than necessary; except when electric heaters are to be used upon the circuit much larger wires should be used, say No. 12 or No. 10.

If the mechanic understands joining the wire electrically as well as mechani-

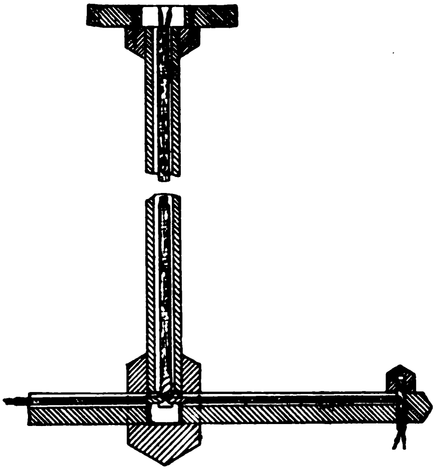


FIG. 2

cally, No. 18 wire may be used in the branches, one side of each branch all being joined to No. 14 wire which extends up through the vertical part. If the mechanic is not familiar with this method, it would, perhaps, be better to let the small wires extend up the entire length, making one side of the circuit so that the number of wires may be properly divided and secured at the terminal of the rosette.

A space at the top of the fixture, as indicated in Fig. 2, may be provided large enough that it will not be necessary to remove the base of the rosette, the wires being secured by the screws under which the feed wires are secured.

The central vertical part of the fixture may be constructed of two pieces glued together. These pieces should be grooved, or slotted, so that when they are secured together there will be a hollow space throughout not less than 1 in. square. The outside dimensions of this part should be 2 in. square or more. The branch arms may be 1¾ in. square or more, with blind slots to receive the wire, as indicated in Fig. 2.

The ⅛ in. pipe nipple, upon which the sockets are to be screwed, should have a drive fit, and a little glue may be used to set the nipple more firmly. As indicated in Fig. 2, the ⅛ in. pipe nipple should have a hole or slot, to receive the wire.

The designs for a chandelier of this kind are unlimited in number; but the design shown, Figs. 1 and 2, possess the advantage that it is as easily wired and assembled as the standard brass fixture.

It is believed the mechanic may find it desirable to make chandeliers of this kind for his own home; and, by looking up the matter of wiring electric fixtures, that he may add a profitable side line.

Making up a Small Gold Solution

Making up a small gold solution is usually a difficult job for the plater who has no equipment for it, says *The Brass World*. He finds it taxes his patience to "cut" the gold and make it into chloride or cyanide. It frequently happens, if the gold has not been properly dissolved in the aqua regia, that the chloride of gold contains too much acid and then the solution made with cyanide and the chloride is not satisfactory. Taking everything into consideration, the production of a gold-plating solution, although it is a simple matter theoretically, is not as attractive as it would appear.

The porous cup method of making a gold solution is the best method known, and it is to be recommended. The gold does not require "cutting" with acid, but is simply placed in the cyanide solution in the jar or stone crock, a piece of carbon placed in the porous cup and the current started. The gold dissolves in the solution, but does not pass through the porous cup.

The gold, therefore, requires no "cutting" or dissolving in acid and the process of making the solution is very simple. In addition, carat golds can be used, if desired, and any desired alloy may be employed by simply using it instead of the fine gold.

This method of making up a gold solution is so simple that the most inexperienced person can use it, and it is to be recommended, particularly when small solutions are to be used, as they generally are for the majority of gold-plating done.

The short ends of arc lamp carbons, says a contemporary, may be joined together and utilized again. They should be cut square, and the ends should be coated with a cement formed of a mixture to a pasty consistency of potassium silicate and carbon dust, and then pressed together by hand. Carbon rods made in this way of a number of pieces are said to burn well on continuous or alternating current, and to be no more brittle than ordinary carbons.

INTERESTING STORY OF PLATINUM

In view of the present-day use of platinum, our readers will be interested in the following story of this remarkable metal reprinted from *Cres-Arrow*, published by Whiteside & Blank, Newark, N.J.:

When we call platinum a new metal we have in mind the antiquity of gold and silver, and the fact that platinum was unknown to the world until 1735, when La Torre, a Spaniard and member of a French scientific expedition returning from Peru, announced its discovery. It was not until 1750, however, that William Watson, the English physicist, described it as a new metal.

Owing to its rarity and little known properties more than half a century elapsed before it was recognized as a native mineral.

In 1819 it was discovered in the gold washings of Verkhniy-Isetsk, in the Ural mountains.

The Russian government, quick to note its character, coined three-ruble pieces of platinum. Today the intrinsic value of the metal in these unique pieces is six times what it was when they dropped from the mint.

ORIGIN OF NAME

Through La Torre's discovery the Spaniards are responsible for the name platinum—platina, its older and equally correct form, being a diminutive of the Spanish word "plata," which means silver.

South Americans called it Platina del Pinto, and it luckily avoided the awkward title "frog gold," or "Mas Kodak," as the natives of Borneo called it in their picturesque language. Among English-speaking miners it bears the common name "white gold."

Because of its being found always in company with a number of other metals, iridium, osmium, ruthenium, rhodium, palladium, and gold, the Greek name "Polyxene," meaning "guest of many," was applied to it by the English Hausman, but this title was too scholarly to stick.

Something less than 5,000,000 ounces of platinum have come to light in the world's history, about 1 per cent. of the gold produced in the same time, and of this about 90 per cent. has come from the northern portion of the Goot of Perm, a district situated in the Ural mountains of Russia.

The land forming the comparatively small area of production is owned by a few of the nobility, who farm it out to peasants for mining purposes, but wisely control its output.

Of what is mined outside of Russia, South America produces about half, and Canada and Australia the bulk of the remainder. Our own United States is credited with less than 400 ounces per year, and this is quite a secondary product of the gold washings of Colorado and California.

OBTAINED BY PLACER MINING

Platinum is always found loose in shallow drift or alluvial deposits, in the form of sandy flakes or small nuggets, and is therefore always obtained by the methods of placer mining. This product of the placer miner, technically known as crude platinum, runs 75 to 85 per cent., and contains sand and metals, which on account of their weight, cannot be separated by this process. A ton of platinum sand yields from a few pennyweights to as much as an ounce and a half of the pure metal.

In the districts of greatest production, Nizhne-Tagilsk and Goroblagodatsk, in the Urals, the deposits contain many pebbles of serpentine, which is believed to have formed the original matrix, since disintegrated.

This platinum dust as received by the refiners is treated by various chemical processes to separate the platinum from the iron or black sand and from the gold, osmium, iridium and other metals present. It is then melted in an oxyhydrogen or electric furnace, which must be capable of generating over 3,600 degrees of heat, Fahrenheit.

After melting, it is poured into ingots of suitable weight. These are subjected while at white heat to great pressure to solidify their particles and are then rolled into plate or drawn into wire.

PLATINUM PROPERLY ALLOYED

Though pure platinum is one of the softest metals, when properly alloyed it becomes one of the hardest.

All the high qualities of platinum are annulled in combining it with inferior

metals. Therefore, iridium, its royal native brother, whose hardness is excessive and whose rarity and value far exceed those of platinum itself, becomes its only appropriate alloy.

It is a rare stroke of fortune both to science and to the arts that the greater the percentage of iridium, the greater the durability and value of the metal. The addition of 10 per cent. iridium makes platinum harder than 14-carat gold, and 20 per cent. added to it makes it so hard that it will practically defy wear forever.

Probably no metal has experienced more fluctuation in value than platinum. In 1874 it was worth $6 or $7 per ounce. In 1898 it had increased to between $10 and $20. In 1907 its price averaged $35. Though it fell to less than $30 in 1908, probably through lack of commercial demand, it has risen steadily since then and has now reached the highest point in its history, being quoted at $46 per ounce. $50 per ounce is the present-day value of iridio-platinum suitable for jewelry making.

VALUE WILL INCREASE

The limited distribution of platinum and the steady increase in its demand during a long term of years give us every assurance that its value will never depreciate.

As art and science come more and more to recognize its marvelous virtues, the price of platinum is likely to soar beyond any height we now imagine.

The splendid character of platinum may best be expressed by those rare physical qualities which not only surpass the properties of all other commercial metals, but place it regally in a class by itself.

First, it has a greater specific gravity than any other known substance, excepting only iridium and osmium, with which it is always found and to which it has the strongest mineralogical alliance.

Secondly, its melting point is far higher than that of any metal known in the

Finally, when combined with its natural alloy, iridium, it possesses a hardness that approaches the absolute.

STANDARD FOR WEIGHTS AND MEASURES

The greatest evidence of its superlative worth is that the nations, seeking a medium that would maintain its character forever, chose platinum from which to make the standards of the weights and measures of the civilized world.

Platinum of standard hardness weighs 58.5 per cent. more than 14-carat gold. And while the gold costs but 64 cents per pennyweight, the platinum has a value of $2.50. As a concrete illustration of the difference in values of the two metals, a gold jewel weighing ten pennyweights would be worth $6.40. If duplicated in platinum it would require fifteen pennyweights twenty grains, and would have a value of $39.58.

For obvious reasons the cost of working platinum is far greater than that of working gold. However, the proportion of cost in relation to the value of the metal is so much less that the finished jewel will possess a far greater percentage of metal value than if made in gold.

The creator of art jewelry, therefore, whose science and skill have subjugated the stubbornly resisting metal, and whose pride is justified by his desire to perpetuate his craftsmanship, is given the privilege of using for his art this ideal medium.

The jeweler prizes every quality it possesses: its hardness, its permanence, its neutral and harmonious color, its capacity for taking a brilliant finish, its intrinsic value and its very rarity. It is costlier and more beautiful than gold and has the essential charm of fitting its purpose exquisitely.—*Keystone.*

Precautions to Observe when Heating Test-tubes

Never have outside of tube wet. Start

DRILLING THROUGH LATHE MANDRELS

OWEN LINLEY

It is always an advantage to have a hollow mandrel, and even in those cases where a hardened center prevents your taking the hole right through, it is a good compromise to make the hole as deep as possible. In fact, if you take the drill down the mandrel until you begin to feel the hardened center you will have a hole which will be deep enough for many purposes. If the mandrel is of such kind that it is possible to drill a hole right through it, and you decide to do so, it is best, if possible, to drill the hole and that of a hole that is not started true radiate like the adjacent spokes of a wheel.

I have drilled the mandrels of several lathes (after they have been made), and have come across a point that would rather give trouble to an amateur. In lathes where the center is carried in the nose, the extreme end of the hole is what is left by the turner when he drills it to make way for the boring-tool, and it often runs out. If it does so, the drill follows it, and it is difficult to prevent it.

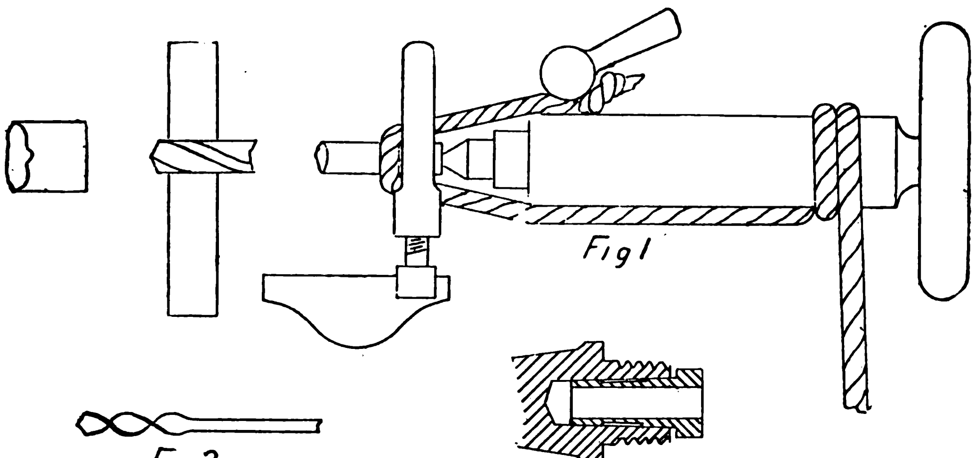


Fig 1

Fig 2

Fig 3

half-way from each end, as it much reduces the time and the trouble caused by the drill running out, as this is sometimes serious if you get the drill started badly. If the mandrel-head is of such type that you can reverse it on the bed, you can do it in its place; or if you have another lathe at your command, you can run the mandrel in that, holding one end in the chuck and the other in an extemporised stay made of hard wood, and bolted to the lathe-bed. Of course, when you drill the back half, and hold the nose of the mandrel in the chuck of the other, you must protect the thread by screwing a chuck or nut on it. In cases where you have to drill entirely from one end, it is most important that the drill should start perfectly true, for if it does not, the chances are that it will go from bad to worse, for the axis of the mandrel You may do this to some extent by clamping the drill in the tool-holder, setting it opposite the center, which you then remove; but, even then, as the drill has to project some distance from the tool-holder, it has very little rigidity. You may remedy this, to some extent, by having the drill very sharp, running the lathe fast, and setting in very lightly until the drill has cut a true start for itself. If this cannot be managed, the best way is to make a bush to go in the center hole, to act as a guide for the drill. This is easily made, and this is, perhaps, the best way for an amateur to go about this, for although you may start a drill true, it will sometimes begin to run out after it has got about a quarter of an inch or so down the hole, and then it is almost impossible to get it right.

Take a piece of mild steel, a little

longer than the center hole, so as to have something to take hold of to withdraw it by. Hold it in the chuck, and drill it up and bore it to fit the drill you are going to use. Say, for example, it is a three-eighth drill. If you put the drill through the solid metal it will cut too large to make a good guide, so if you have a three-eighth bit, it is best to finish the hole with that. If you have not, I will explain how you can make a twist-drill bore a hole its exact size, and this knowledge is useful for other occasions, and for drilling brass. Put a five-sixteenth drill through the bush, and then follow it with the three-eighth. If you do this in the ordinary, it will hook itself into the hole, and jump off the poppet center, but the following simple contrivance will prevent it. Take a piece of cord (ordinary clothes-line will do), tie one end round the body of the poppet, or make a loop, and slip it over the binder nut (see Fig. 1), take the cord under the tail of the carrier, over the drill, under the body of the carrier, and back to the end of poppet-head, and take two turns round it. Now a slight tension on the free end of the cord will prevent the drill hooking it. You must see that the proper tension is on the cord before the drill touches the hole, otherwise it will hook in just the same.

The right way to start the affair is thus: Draw the poppet cylinder back as far as it will go, put the drill against the center, and clamp the head so that the point of the drill is half an inch off the mouth of the hole. Cut a piece of wood with a notch or vee in it for the drill to rest in, so that its point is about opposite the center of the hole. You can have several vees in this piece of wood to take drills of different diameters. Take the drill in the left hand, and having taken the cord round it, and the carrier, as I have described, put the counter-sink at the end on the center of the poppet. Take the cord in the right hand, and by its means pull the and by the time the point of the drill reaches the mouth of the hole, the cord will be in a strong state of tension, and will prevent the drill hooking in.

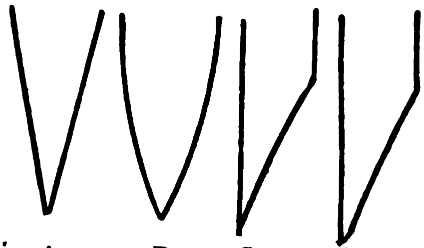
I have used this arrangement for many years, on all sorts of work, large and small, and it is really as efficient as a chuck on the poppet cylinder, and costs nothing. It is also useful for solid holes, especially with new drills, or in brass, as it stops the danger of the drill's bursting through and jumping off the center. Only a slight pull is needed on the end of the cord, on account of the friction of the turns round the barrel, and you let these slip gradually as you set the drill in. If the two lips of the drill are ground alike, it should now make a hole that it does not shake about in. Having got the bush bored, put it on an arbor and turn it to fit the cone in the end of the mandrel. This operation is made much easier if you turn a recess in the middle, as shown in Fig. 2. If you do not use much force in fitting this, and do not drive it in hard, there is no danger of injuring the cone. This bush will not only start the drill true, but will steady it for some way down the hole. Fig. 2 shows a section of the bush in its place. This bush had better be removed after the drill has entered the mandrel about an inch and a half, for it has no effect in steadying the drill after that distance, and gets in the way of removing the chips. Speaking of removing chips, I have always used a spiral scraper made of a piece of wire flattened and twisted, as Fig. 3. To use it, let the lathe run, push it up to the end of the hole, and then withdraw it, keeping it pressed against one side of the hole, and it will draw out chips faster than a hook.

I have also made a practice of twisting the long drill that you have to make to take the hole beyond the twist-drill. This is easily done when they are hot, and it is best to make the end much like the end of the twist-drill proper, as a flat drill cuts mild steel very slowly. I

SHARPENING EDGE TOOLS

W. D. GRAVES

The essential feature of a good cutting edge is that its two sides shall form a sharply defined acute angle, which can only be attained by having both sides straight as shown, much magnified, as *A* in the drawing, rather than curved, as shown at *B*. Where the novice usually fails in whetting an edge tool is in giving it a rocking motion, producing the rounded edge; and the principal element of skill in the operation lies in holding the blade and the stone at the same relative angle throughout. There are some apparent exceptions to this rule, as the common ax; but they are only apparent, not real. An ax used for chopping is better ground with the sides



A B C D
Various Forms of Cutting Edges

smoothly curved, but the sides of the extreme edge, if it is a good edge, must be straight. Of course, these straight sides may be very short, only as long as they are made by the final "setting," or whetting, of the edge, but they are there.

The proper "thickness" of the edge, *i.e.*, the degree of acuteness of the angle formed by the two sides, depends wholly upon the nature of the tool and the work it is intended to perform. A "thin" edge will, of course, cut more easily, but it will also break and become dulled more quickly; so the proper angle must be determined, by observation and experiment, for each tool and purpose. The conservative beginner will aim to err in the way of making the edge too thick; then as he finds it amply strong to do the work without breaking or nicking he will make it a little thinner, and so proceed till he learns the most effective and economical angle. An edge which would be sufficiently enduring on soft pine would become almost immediately blunted on lignum vitae; while, for use on any given wood, differently tempered tools require sharpening at different angles in order to give the best results.

As most wood-cutting tools are sharpened like a chisel, this form of edge may perhaps best be used in illustrating the method of sharpening all. If the tool is very dull the work of sharpening is expedited by first grinding it on a stone or wheel of a grit too coarse to make the final cutting edge; taking care to have it symmetrical and either straight or of the curve of the grinding wheel, as shown at *C*. This method of making the sides inwardly curved—or "hollow grinding"—which is carried to its extreme in razors, lessens the work of whetting, but tends to make the edge weak and incapable of withstanding hard usage.

On the grindstone or abrasive wheel the tool is brought to an edge somewhat more acute than is desired for the finished one; but, owing to the coarseness of the abrasive used, it is too rough for keen cutting. The final edge is "set" by rubbing with or on a flat finishing stone of finer grit, making a new and sharply defined bevel as shown, magnified, at *D*.

All cutting edges are somewhat serrated, some being finished on a stone so coarse that the serrations may be seen with the naked eye, as that of the common scythe. Such edges are made to cut by a sliding action, like a saw; and, for that matter, even a razor will cut much more readily if given a slight endwise motion.—*Scientific American*.

Drilling through Lathe Mandrels

(*Continued from page* 326)

then the hole is often a great convenience. I have drilled as far down the mandrel as possible, until I have felt the drill touch the hard steel plug that is forged into the end for the countersink.—*English Mechanic and World of Science*.

Capt. Hayden, commandant of the Key West, Florida, naval station, has received a letter from Cairo, Egypt, stating that the Lloyds wireless operators in that city had on numerous occasions copied messages sent from the Key West station. The distance is more than 7,000 statute miles, or more than 500 miles further than a former world's record.

EDITORIAL

We take pleasure in announcing that the first prize offered some months ago for the best practical constructive article, of a mechanical or electrical nature, has been awarded to Mr. P. Mertz, whose article, entitled "A Practical Section Liner," is published in this issue. Mr. Mertz' article excellently describes the construction of a useful tool, and his drawings, evidently made with the aid of the article described, show careful handiwork and a thorough knowledge of the subject. Several other articles were submitted in the competition, and it is probable that we shall use some of them in future numbers, in which case they will be paid for at our regular space rate.

We believe that competitions of this kind are of value to both those who take part in them and to other readers of the magazine, and we are especially desirous of developing the descriptive faculties of our subscribers. We will continue, therefore, this series of contests, and will award another prize of Ten Dollars for the best practical article on any mechanical or electrical subject submitted to us before July 1, 1913. The length of the article is immaterial, provided that the subject matter is carefully considered and sufficiently describes the points in question. We prefer illustrated articles, and neatness and finish of drawings will be considered in making the award.

We regret to be obliged to omit from this number the continuation of the excellent series of articles on Mechanical Drawing, by Mr. P. LeRoy Flansburg, whose illness has prevented the completion of his installment in time for

in Mr. Marconi's usual lucid manner. The other, of vital interest to all who are commercially interested in wireless telegraphy, is the latest publication of the United States Government on the subject of wireless telegraphy, and gives the rules for forwarding radiograms from ship to shore through naval stations. It also gives a very valuable list of abbreviations which are to be used after July, 1913, by ships of all nations in sending from one to another, and which are expected to be used immediately by all American ships, in order to save time and diminish the length of messages sent through the ether. Doubtless a knowledge of the information in this communication will be required for the passing of examinations for licenses hereafter, and we recommend its earnest and careful study by every operator.

The task of the Editor in deciding what his readers will find most helpful is not always the easiest of matters, and he is always grateful for information as to what will be most useful and valuable to his clientele. We have in prospect for future numbers many interesting articles but we would appreciate information from readers as to any subjects which would be especially helpful to them, and will make every effort to provide in an early number suitable material on any such subjects which may be suggested to us which seems likely to be of general interest.

New Wireless Records

The United States scout cruiser *Salem* left Gibraltar March 11 on her return trip

QUESTIONS AND ANSWERS

Questions on electrical and mechanical subjects of general interest will be answered, as far as possible, in this department, free of charge. The writer must give his name and address, and the answer will be published under his initials and town; but, if he so requests, anything which may identify him will be withheld. Questions must be written only on one side of the sheet, on a sheet of paper separate from all other contents of the letter, and only three questions may be sent at one time. No attention will be given to questions which do not follow these rules.

Owing to the large number of questions received, it is rarely that a reply can be given in the first issue after receipt. Questions for which a speedy reply is desired will be answered by mail if fifty cents is enclosed. This amount is not to be considered as payment for reply, but is simply to cover clerical expenses, postage and cost of letter writing. As the time required to get a question satisfactorily answered varies, we cannot guarantee to answer within a definite time.

If a question entails an inordinate amount of research or calculation, a special charge of one dollar or more will be made, depending on the amount of labor required. Readers will, in every case, be notified if such a charge must be made, and the work will not be done unless desired and paid for.

1988. **Small Wireless Set.** M. C. K., Philadelphia, Pa., asks: Please publish in your magazine the directions of how to make a small wireless outfit, including the transmitting and receiving sets. Ans.—Nearly every number of the *Electrician and Mechanic* contains the directions for the construction of some instrument used in the transmitting or receiving sets of a wireless telegraph station. By referring to the back numbers you will obtain sufficient instructions to enable you to build a complete outfit. The directions of how to build a small set would interest but such a small number of our readers that it would not be worth while to take the space for such an article. We can furnish you with elementary books on this subject if you desire.

1989. **Dynamo Construction.** L. N., New York City, asks: I am using the armature and field pieces of a magneto to construct a dynamo. Instead of the permanent magnets of the magneto, I am using flat iron ¾ x ¼ in., to be wound and placed in position as in the accompanying drawing. What size wire and how many turns should I use for winding the armature and field magnet (the armature being the ordinary magneto kind, two sections for winding) to generate enough current to light a 6-volt Mazda lamp, 2 c.p. For a 8-volt Mazda lamp. How many revolutions a minute will the armature turn to generate this current? As this construction is for a special apparatus, no part can be changed but the windings. Ans.—In the ordinary magneto generator the spring of the permanent magnets is utilized to hold the cast-iron pole pieces against the armature bearings. With your proposed electromagnet you would have to incorporate the same idea, being careful not to use iron screws extending from pole to pole, else there will be improper paths for the magnetism. The section you propose for the electro magnet is too smal; the iron should be as wide as the vertical flat face of the poles, surely 1½ or 1¾ in., and it should be ½ in. thick. Let the

market yet? Ans.—(1) Nothing further has been reported in regard to this simple form of turbine. From the fact that the manufacturers of the ordinary forms of turbines are making no changes in their designs would seem to indicate that there were positive defects in the practical working of the new form. (2) Gas turbines do not yet seem practical, the reason appearing to be the lack of materials that will withstand the high-working temperature.

1991. **Wireless Wave-Length.** E. S., Deer Lodge, Mont., says: I wish to know how the wave-length of a wireless station can be calculated, or I would be very much obliged to you if you will calculate it for me. My aerial is about 25 ft. above my instruments and they are 20 ft. above the ground. My loose coupler has 145 turns and 16 in. to a turn on the primary. The secondary has about 200 ft. of wire. My aerial is composed of 4 wires, 50 ft. long. Ans.—The wave-length of a wireless set is equal to 1885 $\sqrt{LC}$ meters, where L is the inductance in microhenries and C is the capacity in microfarads. Thus, in order to obtain a wave-length it is necessary to measure both of these quantities. As this is troublesome, the wave-length is determined for commercial purposes by a standard receiving set, or, as it is called, a wavemeter, which is calibrated to give the result directly. Your wave-length would vary with the amount of inductance or turns of wire you were using when tuning to a station. With your set it would probably vary from a minimum 150 meters to a maximum of 1,000 meters.

1992. **Wireless Calls.** C. W V., Yoakum, Tex., asks: (1) What is the call letters of the new station at Arlington, Va.? (2) What wave-length does it operate on? (3) Where are the following stations located: XCP, XCZ, KKA, and RS government station? (4) What wave-length does NAR operate on? Ans.—(1) NAA. (2) 3,800 meters. (3) KKA is the S.S. *Antilles* with New York as her home port

know what size wire to use and how many turns to each coil. Starting coils will be wound in bottom half of slots 1 and 4, 5 and 8, 9 and 12, 13 and 16, then a running coil to fill slots 4 and 5, spreading into 3 and 6, 8 and 9 with 7 and 10, 12 and 13 with 11 and 14, 16 and 1 with 15 and 2. Is this correct, and will an impedance be needed in the starting coil circuit? My current is 110 volts, single phase, 60 cycles. Ans.—The diagram of winding for a small fan motor which you have sent for inspection seems entirely correct, and the result should be a finely working machine. We suppose you will have slots cut in the rotor so as to open the iron directly over the rods. In the design of a fan motor you must recognize that considerable heat is inevitable, and part of the work of the breeze is to keep the motor cool. If you run the motor without the fan, the heat is likely to be serious. Let the starting coils be wound with No. 20 wire, all you can get in the slots, and No. 23 for the running coils. Then instead of putting reactance in the starting circuit, put resistance only, say composed of a zigzag arrangement of bare German silver wire. The size can be No. 20, but the right length can be found from experiment only. This will reduce the lag in the temporary circuit, which, for the case at hand, should be more effective than interposing additional lag. Let us hear the result of your labors.

1994. **Babbitting.** H. E. D., North Haven, Conn., says: Have you a book on Babbitting? This is something I do not understand, in fact, never saw it done, but have done nearly everything else in the mechanical line, yes, and considerable in the electrical line. Well, I have an old Pope-Hartford transmission, in which the bronze boxes are worn very bad, and I am going to overhaul it as soon as I get through with the machine I am working on now. I am thinking of running Babbitt in these boxes. Would you advise it? Other mechanics advised trying it. As I have said before, I have had no experience at this job. I should like a book on the subject before I tackle it, and if you have not any, could you advise me where I could obtain one? Ans.—Babbitting is easily done by anyone who is willing to make reasonable preparations. If a bearing is so worn that the shaft is a poor fit, you cannot merely run some of the melted mixture into the crevice; considerable space must be prepared for it. Remove the bearing from its place, and in a lathe bore out the stock so that a thickness of Babbitt of about 1/8 in. will be provided. Chamber the place rather than bore it out straight through, thereby leaving thin lips at the ends for holding the shaft in its right place and for preventing the melted metal from running out. If an oil hole is already provided, this may be used for pouring in the Babbitt, but possibly the hole should be enlarged, say to 3/8 in. in diameter. Hold the shaft to which a fit is to be made in a gas flame so as to get it evenly covered with smoke. If this is impracticable, merely oil the shaft. Either precaution will prevent the shaft from ... surface of metal is smooth and final shaft is a proper fit. If you have a good equipment of tools, you may use an arbor that is a trifle small, and then ream out the hole to final size. Use a good quality of Babbitt—costing not less than 55 cents per pound. You will get a lot of helpful information as to the procedure by visiting the repair shops of a street railway company.

1995. **Rotary Engine.** R. C., Garliestown, Scotland, says: I was wondering if any rotary engines have been constructed on the enclosed principle. I think an engine to the enclosed sketch might look economically, but I thought from the name of your book *Electrician and Mechanic* you would be able to know how it would look. Ans.—This form is about the very earliest of rotary engines, and has been used by many experimenters. Also, instead of serving as an engine, it has been largely employed as a blower, notably on the famous Thomson-Houston arc lighting dynamos, for blowing out the sparks at the commutator. The defects of the construction lie in the experience that the radially moving blades have a great deal of friction, and soon leak, and also that the thing is intolerably noisy.

1996. **Oscillation Transformer.** R. A. F., Malden, Mass., says: (1) The wireless inspector of this district has advised me to use an oscillation transformer instead of a helix. What are the specifications of one to use with a 3 in. coil? (2) What size condenser should I use? (3) Has a Leyden jar condenser any advantage over the plate type, and if so, why? Ans.—(1) Make the oscillation transformer of the pancake type. Use 3/4 in. copper ribbon for the winding on hard rubber or shellacked wooden frames. The primary should contain three turns spaced 1/2 in. with the maximum 12 in. in diameter. The secondary should contain eight turns spaced 1/2 in. with the maximum 12 in. in diameter. (2) About .005 mf. Use larger if the coil will charge it. (3) Not for use in wireless work.

1997. **Spark Coil.** J. A. S., Kansas City, Mo., says: (1) Which would be preferable as to best spark or best service for wireless, the two spark balls or two halves of a spark ball flat sides facing from the points of sending rods? (2) Can you tell me the length of a spark that can be obtained from a Splitdorf auto coil, which is supposed to give 1,500 volts from a 6-volt 80-ampere-hour storage battery? (3) Can you connect two in series and get twice as big a spark? Ans.—(1) The two spark balls. (2) About 1-16 in. (3) Yes, but you are quite liable to puncture the insulation. Connect the secondaries in multiple and the primaries in series.

1998. **Tuning a Transmitting Set.** K. R., Toronto, Can., says: I have a 1/2 kw. Clapp-Eastham rotary spark quenched gap set, consisting of edgewise wound oscillation transformer, as described by Stanley Curtis in your November number, condenser of three units magnetic leakage transformer and rotary quenched gap. (1) How would one increase or decrease the

have to be changed? (3) How would one tune this set for a wave-length of approximately, say, 500 meters with a hot wire and a wavemeter? The aerial is 190 ft. long and 75 ft. high above ground and instruments. (4) Could this be done without a wavemeter? Ans.—(1) Within moderate ranges you would vary the wave-length by varying the inductance of the oscillation transformer. (2) In order to obtain satisfactory results it is necessary that both the primary and secondary oscillation circuits be tuned to the same wave-length. Therefore, if you desire to alter your wave-length it will be necessary to change the inductance on both the primary and the secondary of the oscillation transformer. (3) To tune the set for a wave-length of about 500 meters, use the three sections of the condenser and vary the inductance of the primary of the oscillation transformer until a reading of about 500 meters is obtained on the wavemeter when a spark is passed in the primary oscillation circuit of the transmitter. While the reading is being made, the secondary circuit should be disconnected. When the desired value is obtained in the primary circuit, inductively couple to it the secondary circuit and vary the secondary inductance until a maximum reading is obtained on the hot-wire ammeter. (4) Not for any definite wave-length. If the primary oscillation circuit is tuned at random, the secondary circuit will be in tune when the maximum reading is obtained on the hot-wire ammeter placed in series with the antenna.

1999. **One-half Inch Spark Coil.** H. F. L., Columbus, Ga., says: (1) I wish you would kindly give me a plan for the constructing of a spark coil so as to produce a ½ in. spark. (2) Please state the kind of material and the quantity required for the construction. (3) Also tell the kind and the sufficient amount of current to operate this spark coil, whether battery or other current. I prefer both or battery. Ans.—(1) Philip Edelman in his book on "Experimental Wireless Stations" has some very interesting data on the subject of the construction of small spark coils. If you cannot obtain this book from your local library, we can furnish it for $2.00 postpaid. You can use any form of direct current from batteries or other source. Rectified alternating currrent would also come under this head.

2000. **Radio License.** L. R., New Durham, N.H., asks: (1) About how far should a 1 kw. transformer rotary spark gap, oil condenser, oscillation transformer and aerial 85 ft. high transmit at night over land, using 200 meters wave-length? I understand that the low wave-length cuts down the range. (2) I shall soon have two poles about 90 ft. high and can place them most any distance apart up to 150 ft. What type of aerial would you advise to give a long receiving wave-length and a sending wave-length below 200 meters? I understand that a condenser in series with the aerial will reduce the sending wave-length and also greatly reduce the range, and that when a duplex aerial is used the larger aerial absorbs most of the waves sent out, but I do not know which is best. One of my poles is almost directly above my apparatus which is on the second floor and the ground wire is 10 ft. long. (3) I am 15 miles from the state boundary and 30 miles from NAC, the nearest station. Could I get a special license to use a very long wave-length, and if so, how could I get such a wave-length? I want to talk with a fellow 30 miles away, and am afraid I cannot do so with the sort wave-length. Ans.—(1) If well tuned, you should be able to work from 25 to 50 miles, but local conditions cause such variations that we cannot give any definite data on the subject. (2) It would be better to use one pole with vertical antenna, which could be used both for transmitting and receiving. (3) It is very doubtful if the Radio Inspector would grant you a special license, unless you held a first-grade commercial license and could give a good reason for needing the longer wave.

2001. **Rays.** A. T., Brooklyn, N.Y., asks: (1) Where can I buy the best instruction books about X-rays Excells, medical coils, etc., so that I may obtain a thorough understanding of them? (2) What effect will ozone and X-rays have over human body? (3) Where is the largest electro medical instrument manufacturing company situated in New York City? Ans.—(1) We can furnish you with the following books at prices quoted: "Practical X-ray Work," by F. T. Adderman, $4.00; "Rarography and the X-rays," by S. R. Bottone, $1.10; "Something about X-rays for Everybody," by E. T. Bubier, 50 cents; "ABC of the X-rays," by W. H. Meadowcroft, 75 cents; "Röntgen Rays and Phenomena of the Anode and Cathode," by E. P. Thompson, $1.00; "Light Visible and Invisible," by S. P. Thompson, $2.00; "Medical Electricity and Röntgen Rays," by S. Tousey, $7.00; "Induction Coil in Practical Work, including the Röntgen X-rays," by L. Wright, $1.25; "X-rays Simply Explained," by L. Wright, 25 cents. (2) X-rays in themselves do not appear to have any affect on the body, although the burns resulting from the high-frequency apparatus used in their production are quite serious. Ozone, chemically known as O3, is a condensed form of oxygen, and breaks down readily in contact with moist substances. In doing so, it liberates nascent oxygen and furnishes a powerful oxidizing agent. Introduced into the lungs it therefore stimulates the circulation and other activities by reason of the increased amount of oxygen furnished the blood. Ozone also acts as a disinfectant and deodorizer. (3) We should advise your consulting the Business Directory of New York City, which is no doubt accessible to you.

2002. **Motor Winding.** W. McN., Albany, N.Y., says: Tell me the amount of wire and the size and how to wind for the armature and field of a Kester bi-polar, 1 h.p. motor, to be used on 30 volts direct current; also tell me where I can purchase Watson's book on storage batteries; also tell me the price of this publication. Ans.—The "Kester" is a design adapted for small sizes only, and you will find better proportions for a 1 h.p. size in various publications. Watson's design, described in "How to Make a 1 H.P. Dynamo," though involving a heavy machine, provides one that can be built with a minimum of tools and labor. We will be glad to suggest the proportions and windings of any other design, without further charge, if you can give us an idea as to the facilities at your disposal for building and running the dynamo. Perhaps

you have underestimated the current input to develop the proposed power. 1 h.p. means a useful effect of 746 watts of electrical energy, but since there are unavoidable losses even in the best of machines, you will have to put in a greater amount than this, and for a machine of the size under consideration, 1,000 watts input would not be unusual. At 30 volts, this would mean 34 amperes. We wonder what source of current you have. To handle such an amount at the commutator would require a larger construction than is usual. You would be better off to adopt 110 volts, whereby 9 amperes would be sufficient, and require commutator and brushes of smaller dimensions, or permit use of carbon rather than copper brushes. The 30-volt machine would certainly require copper brushes, and these cause much more wear and attention than those of the other sort. Perhaps Watson's ½ h.p. machine would fill your needs. It is a fine looking and running dynamo, but is less easy to build. 15 to 20 lbs. of wire will be required for the two sizes. We can supply the book on Storage Batteries.

2003. **Wall Paper Paste.** C. E. C., Fairfield, Conn., asks: (1) What are the best paying positions outside of the Government and the salary? (2) How to make a good paste for wall paper. Ans.—(1) There seems to be no limit to the amount of salary a man can attain to in the United States, provided he has the necessary qualifications. Employers are always looking for those to whom they can pay higher salaries provided they can get more efficiency in the work. There is no field wherein high salaries cannot be attained by those who are able to deliver the goods. (2) Boiled flour paste is usually used for paper. Use a cheap grade of rye or wheat flour, mix thoroughly with cold water to about the consistency of dough, or a little thinner, being careful to remove all lumps; stir in a tablespoon of powdered alum to a quart of flour, then pour in boiling water, stirring rapidly until the flour is thoroughly cooked. Let this cool before using, and thin with cold water.

2004. **Protective Device.** H. S., Chicago, Ill., asks: (1) Will you kindly tell me how to construct a "protective device" suitable for a 1 k.w. flexible step-up transformer; that is, an instrument to prevent "kick-backs"? (2) What is my wave-length? I have an aerial 35 ft. high, 95 ft. long and six strands. Ans.—(1) A very satisfactory protective device consists of connecting two 1 m.f. telephone condensers in series across the line supplying the transformer. The common terminal of the condensers should be grounded with a wire at least as large as the line wire. A small spark gap set at about 1-32 in. should be connected

"head" was not involved. Ans.—There are errors in the answer to which reference is made, both typographical and in statement, and we are glad to rectify them. The formula reads, H.P. $\frac{Qh}{650}$, but explicitly states that this makes allowance for the loss in the wheel, whereas your note seems to indicate that this was the entire theoretical power, so in this point the answer is clear, but the error consists in not using H, meaning the "head," in place of "h," referring to the height of water above the weir. That is "h" was used with two meanings and led to confusion. To state the matter anew, a determination of the horse-power must be made on the basis of the number of foot-pounds in a given time, say per minute. If h = the height (or depth) of water as measured at the weir, and b = the breadth or width of the opening, both in inches, and the velocity of flow, by Torricelli's law, $V\ \sqrt{2gh}$, the number of cubic inches per second can be expressed as $Q\ bh\ \sqrt{2gh}$. The value of "g" is, as usual, 32.2, meaning the acceleration of gravity in feet per second. Since the weight of water is .036 lb. per cubic inch, 28 cu. in. will be required to make a pound. Then the weight of water passed per second will be $28bh\ \sqrt{2gh}$ lbs. If, after passing over the weir, the water falls a distance of H ft., the foot-pounds represented will be $28bh\ \sqrt{2gh}\ H$, and since 1 h.p. is equal to. 550 ft. lbs. per second, the theoretical horse-power will be $\frac{28bh\ \sqrt{2gh}\ \ H}{550}$. In the article in question, 25 was given instead of the correct number 28. If the dimensions of the weir are taken in feet and the flow in feet per minute, the quantity would be in cubic feet per minute, and since the weight of a cubic foot of water is 62.4 lbs., the number of feet pounds per minute would be $62.4\,Q$, and if the fall was H ft. in height, the horse-power would be $\frac{62.4\ QH}{33{,}000}$, which reduces to $\frac{QH}{530}$, but allowing for inevitable waste effort, a common value of the denominator is taken as 650, meaning that the efficiency of the wheel is 80 per cent. The particular sort of wheel to use depends upon the comparative values of Q and H. If the quantity of water is small but under a high head, the "impulse" type, well illustrated by the Pelton make is best, but if Q is large and H is small, the "reaction," or ordinary turbine is required. Under appropriate conditions each can show an efficiency of 80 per cent.

2006. **Electrocution.** L. W. W., Lawrence, Mass., asks several questions as to animal

reliable than at present, horses were frequently electrocuted by getting tangled in a fallen wire. Poor joints in the track alone have never produced death. It seemed strange that while a man would often be involved in the same tangle he would escape with only meager burns or shocks. The reason was not and may not even now be entirely plain. However, it may be that while horseshoe nails are not supposed to enter any vitals, they may be more conductive into sensitive regions than we suppose. Again, a horse is likely to fall so as to bring his bare perspiring body into better contact with wires and track than a man whose clothing would be expected to make him almost immune. Under these divergent conditions, it may not be strange that a pressure of 500 volts may send enough current through a horse to kill him, while it is not uncommon for a man to get against the wires with comparative impunity. Boys, however, have been killed when in contact with such circuits. Under special circumstances men have been killed when the pressure was quite low, as was once illustrated in a Turkish bath establishment in London, when a man standing in a copper lined tub took hold of an accidentally grounded electric light fixture. This was a case of direct current supply at only 200 volts. It was not proved, however, that the electric current did such direct killing as in the case of criminals, for the fatality may have been more directly due to fright and heart failure. The lowest reported voltage with alternating current that produced death was recently in a mill in Providence, R.I., the pressure being about 350 volts. This would be equivalent in effect to about 600 or 700 volts with direct currents. In criminal electrocution, the pressure employed varies from about 1700 to 2000 volts, alternating, and under the special preparations for the circuit the current amounts to 7 or 8 amperes. Momentary contacts with sources at much higher voltage are not necessarily fatal, as was recently illustrated at Pittsfield, Mass., when one of the student-engineers accidentally took hold of the terminals of a 33,000 volt transformer, finger rings were melted, and the flesh burned away to the bone, but aside from these burns the man was not injured.

2007. **"American Electrician."** T. N. M., St. Louis, Mo., asks: Is there a magazine called the *American Electrician* (not *American Machinist*)? If so would like to know where published. Ans.—*American Electrician* was absorbed by the *Electrical World* (McGraw Pub. Co., N.Y.) in about 1906, and so is no longer published, but a monthly edition of the latter is supposed to cover the same ground. Subscription $1.00 per year.

2008. **Electric Elevators.** J. S., New York City, asks: Can you give me any information where I can get a book dealing on the subject of electric elevators. Ans.—"Elevators: Hydraulic and Electric," is a handbook containing full description and illustrations of the mechanism of all the modern types of electric and hydraulic elevators; also instructions regarding their care and operation; the danger incurred by careless handling is clearly set forth; a series of questions and answers follows. Designed for the use of engineers and operators. By Calvin F. Swingle. Price $1.00. The "Trust" elevator manufacturers, the Otis Elevator Co., Yonkers, N.Y., have various publications that can probably be secured for the asking.

2009. **Induction Motors.** J. B. W., Sault Ste. Marie, Mich., asks: Will you kindly let me know if you have any books or printed matter for sale which treats on winding of small induction motors (1½ h.p.)? I mean stator winding; if you have, please let me know the price of same. Ans.—The only adequate book of which we know is Hobart's "Electric Motors." Price $5.50. This, however, does not describe small machines. His book on "Armature Construction," price $7.50, you will find very profitable, but this, too, does not treat of small machines. Another book that deals rather more with the theory is by Bailey. Price $2.50.

2010. **Clock Magnet.** H. J. T., Loudonville, Ohio, asks: (1) We want to operate a magnet for a magnet release on a clock movement, which will be located a mile or a mile and a half from our office. With what size wire and how many turns will be required in the magnet? (2) How many cells and what kind would you advise? (3) We have a 14 gauge iron wire up, can talk over it with telephone, but cannot ring a door bell through it with open circuit (dry batteries). Can you advise how to figure out how many cells it takes to overcome the resistance and still work our magnet, which will require 3 or 4 volts (two cells will operate it on short circuit)? Ans.—(1) We would not advise you to change the magnet in the clock, but to use a 20 ohm relay at the end of the line. This would require less energy than the clock and would be more certain in its action. (2) Using the relay it will be necessary to have two dry cells in the clock circuit and about six in the line circuit. (3) To find out how many cells it is necessary to have, it is necessary to know how much current is necessary to operate the mechanism. Knowing the current, I; the electromotive force of the cells, E; the resistance of the line and mechanism, R; the resistance of each cell, B; the number required will be:

$$N = \frac{IR}{E-IB}$$

2011. **Storage Batteries.** W. C. H., Manomet, Mass., asks: Will you please settle an argument on storage batteries for me? (A) claims that the term "charging" storage batteries is wrong, as there is no such thing as charging or storing electricity in the cells, but that the electricity simply removes the foreign substance from the plates, allowing the acid to work on the plates, thus restoring them to their (the plates) normal condition to be acted upon by the chemical process. (B) claims that electricity is stored in the cells by charging them with an electrical current, but in order to hold the current these must have the chemical action. Now, if the electricity does not stay in the battery when it is charged, where does the electricity go? Ans.—If our opinion will serve in any respect as a peacemaker, we will be very glad to give it. It is certain that widely

different views can be held on matters pertaining to electrical behavior, for as yet no one knows what electricity is, and therefore one person's opinion may be worth as much as another's. Whatever electricity is or is not, there is, however, no more reason to consider that it remains or resides as such in a storage cell than in a plating tank. Now, one of the fundamental ideas about electricity is that it is incompressible. This means that in a given piece of apparatus, just as much electricity must come out as went in. For instance, when an electric lamp is passing a certain current, an ammeter indicates the exact amount whether it be connected on one side of the lamp or the other. If there was any storage of actual electricity, an ammeter on the incoming side would read higher than on the outgoing. The nearest case to genuine storage is in the case of a Leyden jar, or other form of condenser. In the plating tank or storage cell chemical work is done, and that work abides after the current stops, so that whereas it is common and sufficient to use the expression "charging," it should be recognized as merely a convenience, and no more accurate than the equally incorrect yet acceptable expression "sunrise" or "sunset."

2012. **Storage Battery.** S. C. H., Cleveland, Ohio, asks: I am making a storage battery of lead plates, 7 x 7 in. by ¼ in., shaped grooves cut 1 in. apart dividing the plates into squares on both sides with 3-16 in. hole drilled through the plate where the grooves cross. Plates are ¼ in. apart, and I figure about 100 square inches exposed to the acid. With 5 of these plates in a cell (1) what would be the capacity and at what rate should it be charged? (2) What part of sulphuric acid should be used with water? (3) What voltage should be used to charge 10 cells? Ans.—It would seem that you had cut so few grooves as to make the increment of area hardly noticeable. With plain sheets the area of each side would be 49 square inches, and with both sides counted you will have 98. Add to this the narrow edges and you will have the 100 sq. in. without counting in the cuts you have made. You should have the grooves cut as closely together as 14 or 16 to the inch, with a resulting active area of 500 or more square inches. You will find descriptions and directions for cutting such in Watson's book on "Storage Batteries." If completely cut in this manner, you can charge at a rate of 4 to 5 amperes per plate, so that with five such positives and six suitable negatives you can use 20 to 25 amperes. You must allow 2.5 volts per cell for charging. Do not undertake to make a storage battery

secondary voltage on 110 v. d.c. (3) What would be the per cent. efficiency? Ans.—Your enquiry seems to indicate the ordinary "induction" coil type of transformer, windings being perhaps 10 in. long. We do not know of any successful use of such coils on 110 volts alternating current. The usual primary winding would consist of only two layers of No. 14 wire, and the current derived from batteries. Six storage cells will be found to give best results. If you employ 110 volts, the number of turns of wire in the primary will be so many as seriously to increase the self-induction, and therefore reduce the sharpness of the interruption. On open circuit, the secondary voltage would approach the number resulting from the ratio of the number of turns in the two windings. With the coil at work, the effects of magnetic leakage and ohmic resistances produce results altogether indeterminate. As the secondary output cannot be measured, there is no way to find out the "efficiency." With the closed core type of transformer, the results can be closely predicted.

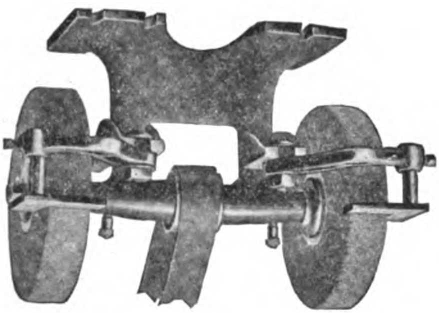
2014. **Rheostat.** Mr. F. J. B., Washington, D.C., asks: Various electrical companies use a sort of porcelain insulation on the backs of small rheostats and the resistance wires are imbedded in this; (1) What is the composition of this insulation? (2) How is it applied? (3) How or where can I find directions for the construction of a carbon resistor that is capable of developing heat sufficient to prepare brass for casting? Ans.—(1) Such rheostats are known as the "enamel" sort, the purpose of the enamel being not alone to serve as insulation, but as a conductor of heat. The wire constituting the resistance has a very small area exposed for radiation, and, in contact with the air only, its current capacity would be much less than when buried in the enamel. This result is quite unexpected, for at first thought one would believe the wire would be so prevented from cooling off as to reduce its capacity. The explanation is found in the fact that the enamel is very thin and is a fair conductor of heat, and conducts it to the ribbed iron backing that still further increases the area for radiation. (2) To make the enamel you can follow the regular procedure for making cooking or sanitary vessels. Of course there are various processes, some of them more easily applied than others, and also having varying degrees of permanence. First the iron must be covered with a "flux," and this can be made from a mixture of white lead, 10 parts; ball clay, 1 part; flint glass, 10 parts, and whiting 1 ... When fused, this is to be run upon the ... is to be laid in place.

TRADE NOTES

A NEW Power Grinder

A conservative estimate of the number of farms on which gasoline engines are used would place the figure between 40 and 60 per cent. There has been a great call for a cheap, durable and fast cutting grinder to be run by gasoline engine.

In putting out the new power grinder No. 308 and No. 309, the Luther Grinder Mfg. Co. have been able to make a strong, heavy machine, at a very low cost. The No. 308 is equipped with a medium Dimo-Grit tool sharpening wheel 7 x 1¼ inches in size. The No. 309 is practically the same as the No. 308, but has a fine grit wheel in addition to the medium one. These wheels are held on by flanges. In case of the 309 with the two wheels, the driving pulley is situated at the center of the machine.



With the 308 the driving pulley is at one side and the sharpening wheel at the other. The belt can come from above, from the side or from directly beneath. All bearings are extremely long, wide and heavy. The manufacturers are willing to guarantee all the parts of the machine for many years.

The sharpening wheel is of Dimo-Grit, the new fast cutting wheel for steel. Dimo-Grit is a further development of Carborundum, having all the best features of that well known substance and the additional advantage of leaving a smooth cutting edge on steel tools. Dimo-Grit is manufactured by the electric furnace process. In case this grinder is desired with Carborundum wheels instead of Dimo-Grit the number is then 308C and 309C.

BOOK REVIEW

Lefax. Loose leaf engineer's reference book founded by John Clinton Parker, published [illegible] Corporation. Pennsylvania

It takes care not only of the data sheets published by the Standard Corporation, but of the engineer's own notes, and of data published in periodicals, for such may be filed on blank sheets of the same standard size as the data sheets, and indexed among them. Clippings can be so pasted or a synopsis of the article written on the blank sheet. Subscribers are invited to suggest subjects for data sheets, and such as furnish data sheets which are accepted will be paid for them.

On each sheet a filing index is printed which can be modified at the individual user's pleasure.

In the sample sheets sent out are tables of logarithms, circumferences and areas of circles, the 1912 standard of flange fittings, actual evaporation per boiler horse-power and factors of evaporation for saturated steam, properties of saturated steam from the new Marks & Davis tables, actual evaporation per boiler horse-power and factors of evaporation of superheated steam, 100 deg. superheat, sheet metal and wire standard gages, and an example of the advertising sheets sold to manufacturers of equipment for presenting data of interest to engineers. The one given among the samples is from the Parker Boiler company, and describes the design of a Parker downflow boiler.

Thick-Lens Optics. An Elementary Treatise for the Student and the Amateur. By Arthur Latham Baker, Ph.D., New York, D. Van Nostrand Co., 1912. Price $1.50 net.

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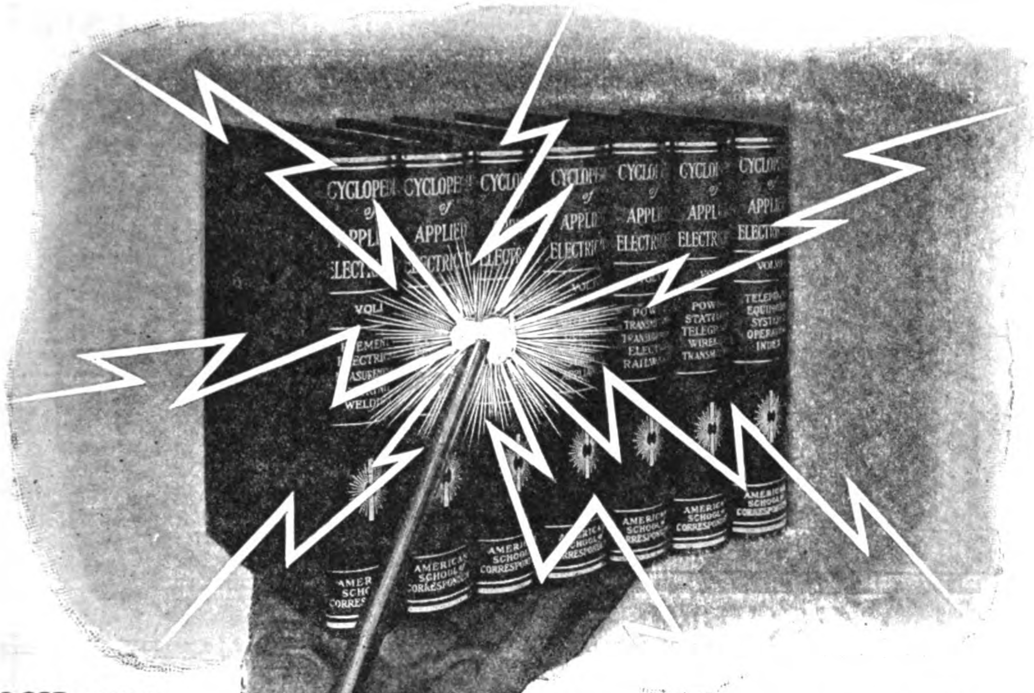

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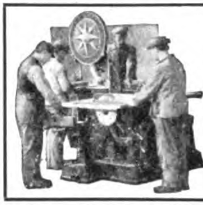

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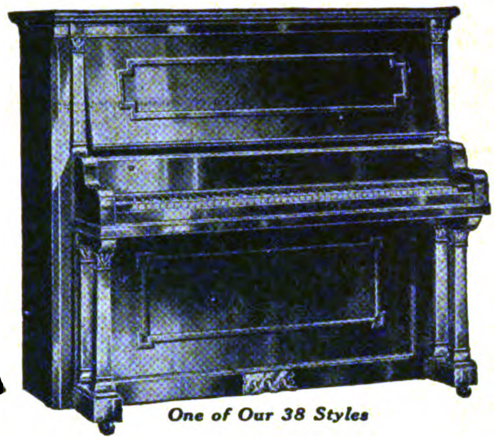

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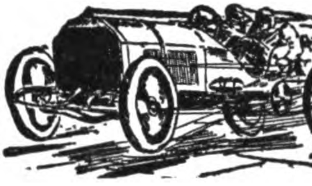

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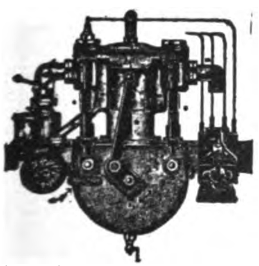

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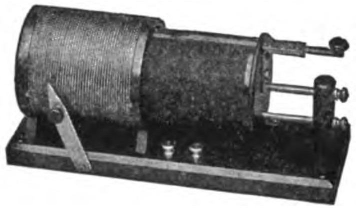

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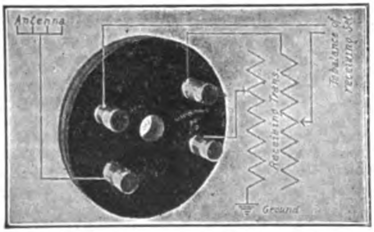

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Postal Life, N.Y.

ELECTRICIAN & MECHANIC

VOLUME XXVI JUNE, 1913 NUMBER 6

MAKING A JAPANESE PERGOLA

GEORGE F. RHEAD

The pergola shown in our illustration, Fig. 1, would be suitable for either a town or country garden. It is such as an amateur worker with even the most rudimentary knowledge of joinery could construct, for outside woodwork does not call for the absolute exactness of indoor work, while the method of jointing chosen is of the simplest, and will be clearly understood from our diagrams.

The measurements for a small-size pergola are given in the half front and side elevations, Figs. 2 and 3, and although for practical purposes the size of the structure could not be reduced to any extent, it could be very easily enlarged in scale to suit one's requirements.

In Fig. 4 is shown the preliminary framework; the four posts are of 3½ in. square wood and measure 7 ft. 6 in. in length. The carcass being 6 ft. wide, and 4 ft. 6 in. from back to front, four rails are prepared, two of each measurement, but with an allowance of at least 3 in. added for the tenons. The rails at the top measure 5 ft. in length, for the joint is cut to extend the whole thickness of the wood at first, a portion being later cut away to fit the front-board of roof (see Fig. 4). The best joint to employ at the top would be the dovetail tenon shown in Fig. 5*a*, which is really quite an easy joint to make, providing it is marked out carefully at the beginning, and when finally a couple of nails

1 in. board 6 ft. 9 in. in length and 3½ in. wide, and is inserted through slots cut in the posts at a distance of 6 ft. from the ground, small slots being cut in the rail where it projects from the posts on the outside, for inserting wedges, Fig. 6, which will allow the uprights to be adjusted to a perfectly vertical position

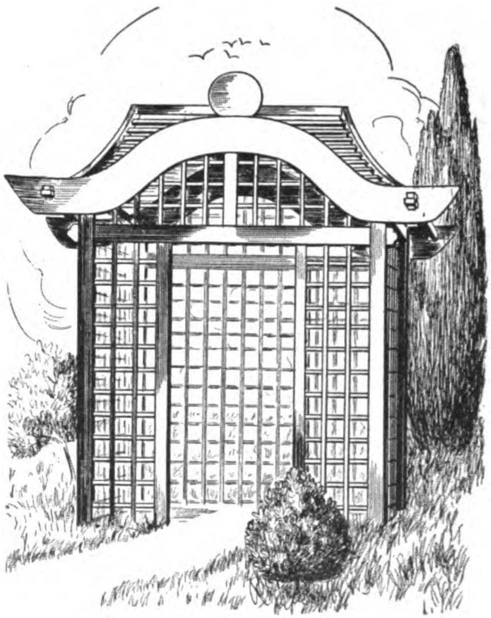


Fig. 1

at will. In fixing, employ a waterproof glue at all the joints, and, of course,

use waterproof glue or dowels for jointing. The upper board, it will be observed in Fig. 8, need only measure 4 ft. 6 in. in length, and the lower 8 ft. 6 in., and the curve is shown marked out in our sketch. Cut away the waste with a keyhole saw, fixing the work in a bench-screw if possible, as shown in Fig. 9, or if the worker is not the lucky possessor of one, a couple of screws inserted through the waste portion of the wood into an old kitchen table, or bench, will afford a fair substitute. Two of these curved pieces will be required; they are jointed together by means of struts, which are halved and inserted through slots cut near their ends and wedged on the other side; the joint in, Fig. 11, *A* and *B*. Both joints are secured with spike nails. Narrow strips are now nailed upon each side of the raking pieces to form an attachment for the laths of roof, which are then put in.

The upper and lower parts of structure may now be put together, the upper portion being jointed to the posts which are halved at the top by two 4 in. screws through each. The upper portion is also further screwed by the center-board of front, which is tenoned into the lintel and curved roof, the latter being for safety fixed to a strut marked *A* in Fig. 3, which will prevent the possibility of its movement during a high wind.

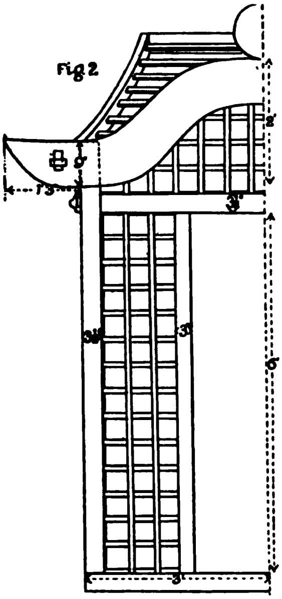


Fig 2

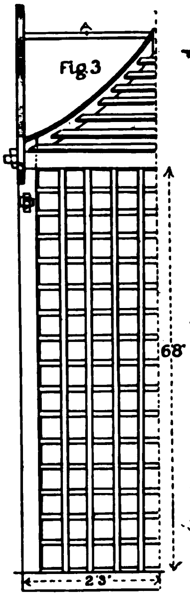


Fig 3

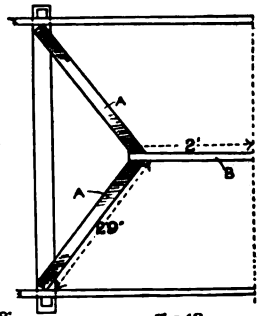


Fig. 12

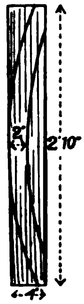


Fig. 10

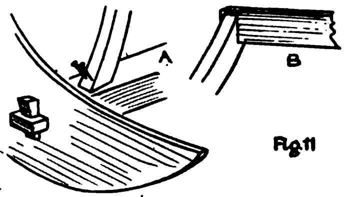


Fig. 11

being made clear by a glance at our perspective view, Fig. 1.

The making of the curved pitch roof requires a little care, but with patience the initial difficulties may be easily surmounted. The curved raking pieces marked *A* in the plan, Fig. 12, are cut from a board measuring 2 ft. 10 in. x 4 in. x 1½ in., the width of the curved piece when cut being 2 in., Fig. 10. These pieces are notched at their upper ends at an angle, which can be easily found

There is now to be added the circular piece at the top of arch, which measures 12 in. in diameter. A little of the bottom of this is cut away so that it may fit the curve of arch, to which it is secured with dowels.

The pergola is now quite complete, with the exception of the lattice-work panels, which are made separately. The most inexpensive and convenient material to employ for these are plasterers' laths, which are procurable in bundles

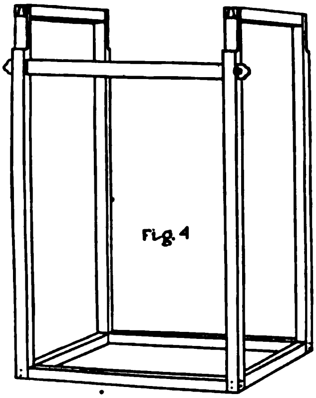


Fig. 4

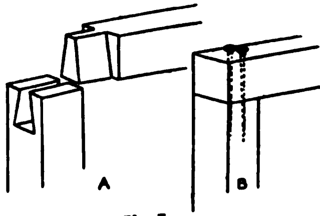


Fig. 5

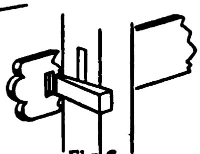


Fig. 6

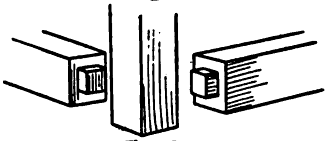


Fig. 7

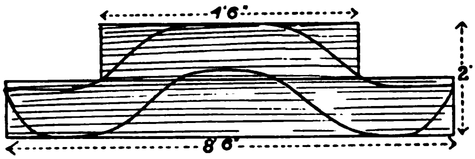


Fig. 8

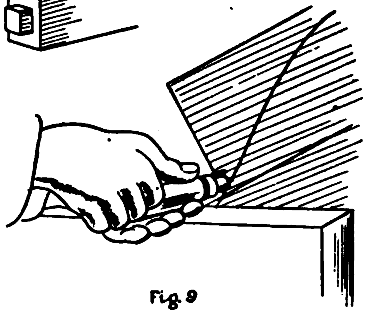


Fig. 9

will also save the necessity of marking out the position of each lath. This is made the same width as the distance between the laths—in the present case 4 in.—and the grooves, which are the width and depth of a lath, are set apart the same distance.

A series of laths are laid in the grooves, and the board is then tenoned with the grooves downwards. It then forms a guide for nailing on the upper laths, it being moved along one, as each lath is applied, and thus not only saves measuring the positions, but keeps the lower laths in position during the nailing.

The trellis panels are attached to strips nailed round the openings where they are applied.

When completed, at least two coats of paint should be given, and this matter should also not be neglected at subsequent intervals.

WORKING OF THE NEW LAW

Secretary of Commerce Redfield is in receipt of a statement from the Bureau of Navigation, showing that during the first four months of the operation of the act to regulate radio communication, which took effect on December 13, 1912, the Department of Commerce, through the Bureau of Navigation, has issued 3,407 licenses to wireless operators and stations in the United States. The first grade commercial operator's licenses number 1,279, second grade 186, while 1,185 amateurs have been licensed, although work with the latter class has been delayed to push the licensing of commercial stations and operators. Eight operators' licenses of the experiment and instruction grade have been issued.

The Bureau of Standards has designed special testing instruments for the purpose of measuring wave-length, decrement, etc., to reduce interference and insure the orderly use of radio-communication, and these instruments are now being put into the hands of the ten inspectors in the field, who will be fully equipped by the end of the month. Thus far forty-six American ship stations and eighteen coast stations have been licensed, and this branch of the work will now proceed more rapidly. Six hundred eighty-five amateur stations have been licensed. The inspections already made have considerably increased the efficacy of wireless apparatus on ship and coast stations. The wireless apparatus on ocean passenger steamers has been inspected before about 1,500 sailings from the United States during the four months.

AN X-RAY SET FOR STUDENTS

EDWARD H. KURTH

A great many experimenters and students have wished to own an X-ray outfit of moderate power, but due to the great expense if purchased, have been unable to procure one. An effort will be made to show how at small expense an outfit can be made, by which different sections of the body and small animals can be photographed by means of the X-ray.

THE TRANSFORMER

The transformer rightly comes first, because on this depends the power of the outfit. The type used is the closed core magnetic leakage ¼ k.w. transformer. As a very suitable one of this style was described in the August and September, 1912, issues of this magazine no more space will be given to this part of the outfit.

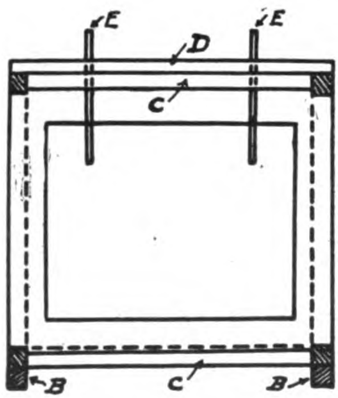
THE CONDENSER

The condenser consists of 20 glass plates 8 x 10 in. covered on both sides with heavy tin-foil 6 x 8 in. placed 1 in. apart in the frame. It is made of maple, stained and polished. The plates are connected as shown in Fig. 2 in the drawing.

THE TESLA COIL

The secondary is wound in one layer of No. 30 enameled wire, spaced about the width of the wire apart. The tube is made of cardboard, and is 4 in. in diameter and 20 in. long. The primary is wound on the frame, made as shown in the drawing, and consists of six turns of No. 4

Fig. 1.



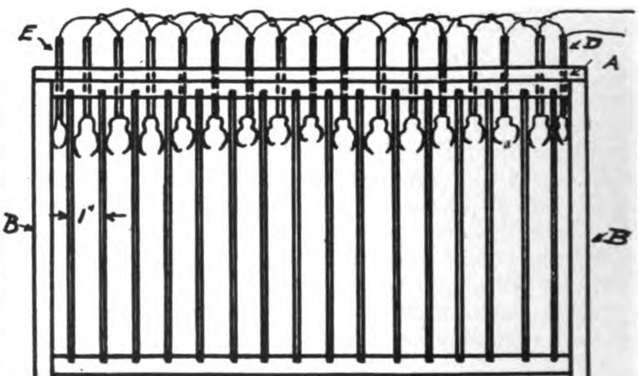


Fig. 2

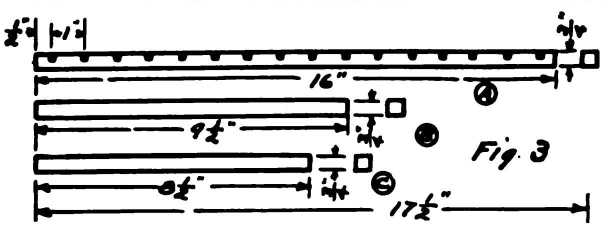


Fig. 3

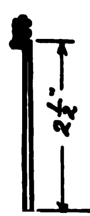


Fig. 4

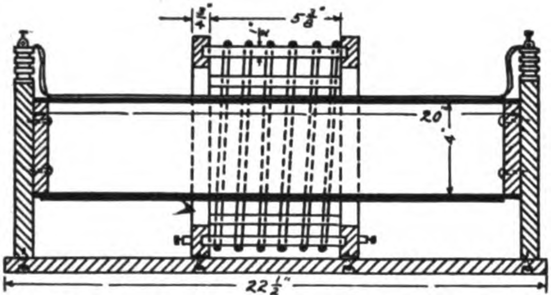


Fig. 1

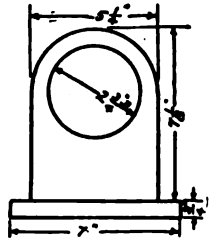


Fig. 2

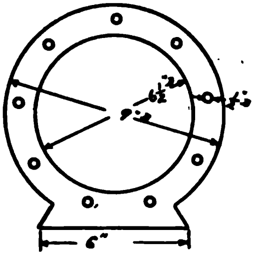


Fig. 3

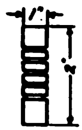
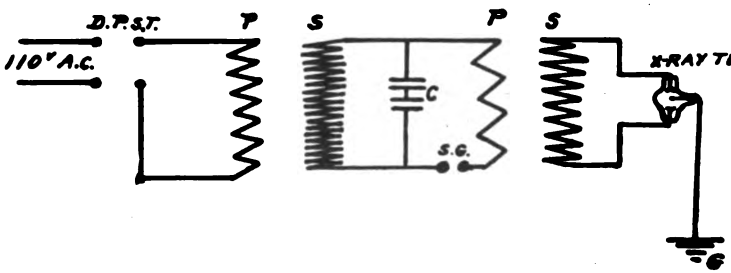


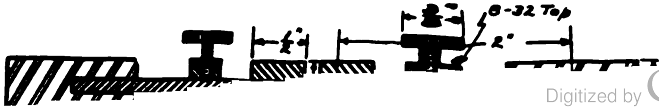
Fig. 4

B.&S. brass wire. The whole is then mounted on the base, as shown in the drawing, and each end of the secondary connected by means of a small copper strip to the binding-posts mounted on the rubber posts. The ends of the primary wire are connected to binding-posts on the rings.

THE SPARK GAP

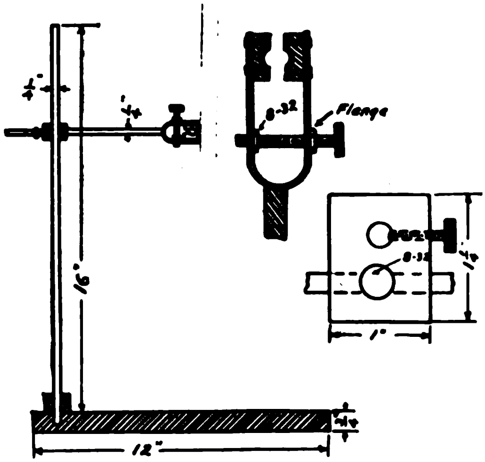
The spark gap is next to be considered. It is of the common wireless type and consists of 2½ in. zinc electrodes screwed on the ends of 2 in. lengths of ⅛ in. brass wire. The standards are 5/16 in. brass rod and mounted on a ½ in. rubber base. Details may be had from the drawing.





THE TUBE HOLDER

The tube supporter consists of a ¼ in. or 5/16 in. brass rod 16 in. long. In this



slides the adjusting block; a small block of brass shown enlarged in the drawing. The taps are 8-32 thread. The horizontal arm is made of ¼ in. brass rod, on the end of which is the tube clamp, which consists of a small bow of brass with felt-lined jaws and a tightening screw. The whole is mounted on a 12 in. square maple base, which forms a rest for the object to be radiographed and the plate holder.

The tube used to secure the best results should be of the double focus style and extra fast plates should be used. The connections aré shown in the drawing. It is not absolutely necessary to ground the center terminal of the tube, but sometimes better results are obtained in this way. The time for exposure to the rays can be determined only by experiment.

KNURLS

Please give me some information about using knurls. I bought a set containing eighteen assorted patterns with a holder, and thought all there was to do was to put your work in a lathe, hold the knurl against it while it was revolving very fast and transfer the pattern to the work, but it does not work at all. The most I can get is a poor job of ordinary milling, like that on a coin. In making tools for my own use I wanted to have a nice finish on them, same as on the ones we buy. A brief description of how to do it will be highly appreciated. Also please tell how the finish resembling engine turning is put on screw-driver handles and such things; it looks as if it might have been done by milling with a knurling tool and my set contains several with that kind of pattern.

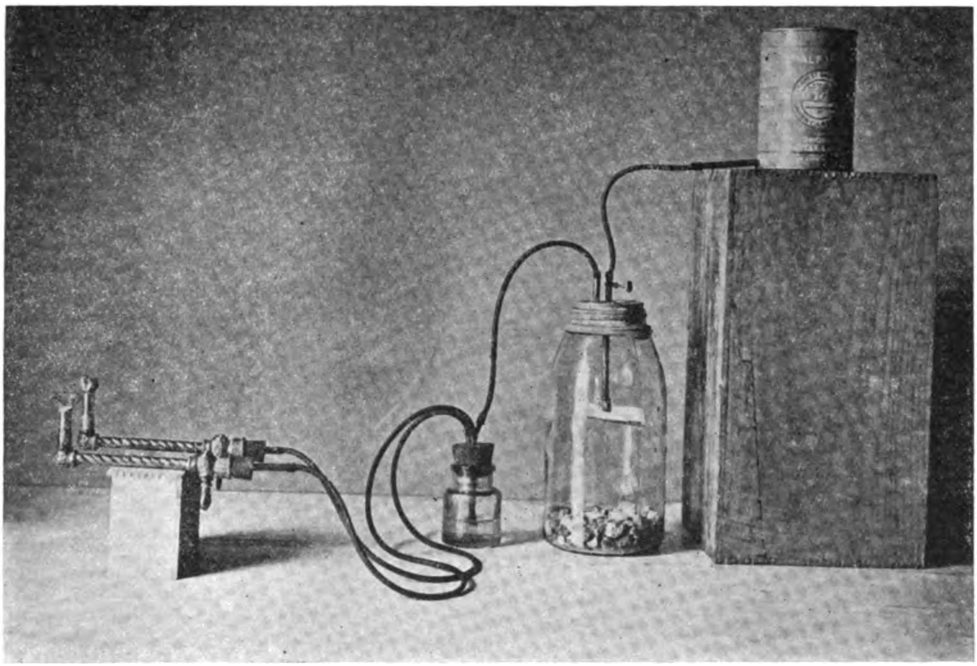
The way to use a knurl is to run the lathe *slowly*, and apply the knurl to the work with *heavy pressure*. You have been doing just the opposite, which is the reason you have not been successful. Let us remind you that the heavy pressure which must be used, makes it necessary to mount the work very solidly in the lathe. For instance, if you are making a screw with a brass head, such as a binding-screw, to have a knurled or milled edge, you must not attempt to knurl the head after you have fastened it to the screw, because the pressure of knurling will bend or break the screw, or spoil the threads where held in the chuck. The knurling should be done before cutting the piece off of the rod of stock, so that the knurled diameter is not much greater than the metal which connects it with the stock, so as to avoid all risk of bending or breaking off the knurled part, which can afterward be separated from the stock by turning or sawing. If the knurling is to be done on a disc which has been sawed from flat metal, the disc should be centered and drilled and held on a strong arbor chuck; or, if drilling is not permissible, it can be soft-soldered to a brass plug-chuck, or if not of large size or width, to a short cement-brass, or even to a thick piece of brass rod held in a split-chuck. It sometimes is advisable to support the free end of the work with the tailstock.

The kind of knurling which you describe as sometimes seen on screw-driver handles, like a continuous engine-turned surface, is made by a special machine in which a number of knurls are fastened to a revolving head, on sliding bars which are pressed toward a common center, which, of course, is also the axis of the rod which is being knurled. This kind of operation would be impracticable unless very large quantities of work are to be produced.—*The Keystone.*

A HOME-MADE ACETYLENE GENERATOR

CHARLES I. REID

A reliable and very cheap acetylene generator may be made from an ordinary Mason fruit jar, a one-quart size being large enough for two one-foot (48 candle power) burners, or a proportionate amount of other sizes. If more burners are desired, use a two-quart jar. Having secured the jar, procure about two feet of copper tubing with an inside diameter of ⅛ in., also a supply of rubber tubing (in the absence of gas tubing, nursery tubing will do). Knock the porcelain



out of the cap for the jar, and drill two holes through the zinc, one in the middle and one near the side, just large enough to pass the copper tubing through. Cut a piece of the copper tubing long enough to reach about half way to the bottom of the jar; solder this tube in the hole in the middle of the cap. Also cut a piece of the tubing about two inches in length and solder it in the side hole to let the gas out of the generator. Both tubes should be soldered air-tight; but zinc is treacherous metal for soldering, and a tinsmith's help may be useful. Attach

giving a more steady light. Attach some kind of a spigot to the top of the long tube to control the water, one with a needle point being the best.

The water can be supplied from an ordinary tin fruit or carbide can by punching a hole in the side near the bottom and soldering in a piece of tubing, making connections between the can and the generator by means of a piece of rubber tubing.

This completes the generator, which is now ready for use by simply filling about one-fourth full of carbide. The cover should be screwed on tightly, and it is advisable to use two or three rubber gaskets to prevent possibility of any gas escaping.

After connecting the burners by means of a piece of rubber tubing, turn on the water just a little, and after waiting a few seconds, light the burners. If the flame is scattered, do not let the water drip so fast; but if the flame is not full size, turn on a little more water.

A safety device is advisable, as this

with a piece of sharpened copper tubing. Now, cut two pieces of copper tubing, one about one inch and one three inches in length, and pass them through the holes in the cork. Fill the bottle about one-fourth full of water and insert the cork, making sure that the long tube passes into the water. Connect a piece of the rubber tubing to the generator with one end and to the long tube of the safety bottle with the other end. Connect another short piece of the tubing to the burner and to the other tube of the safety bottle. If more than one burner with this device is desired, make an extra hole in the cork of the safety bottle for each additional burner and insert long pieces of the copper tubing.

The luminosity of acetylene can be greatly increased by adding hydrogen peroxide to the water used in the generator. One and a half ounces of twenty-volume peroxide in ten ounces of water increases the light seventy per cent.

A SELF-RECORDING DICTOGRAPH

A self-recording dictograph, which could not only overhear a conversation in a room where its presence was not suspected, but could make a full record of the conversation, whispers and all, on a phonographic cylinder located some distance away, is being exhibited in New York by K. M. Turner, the inventor. The secret of how to build such a self-recording dictograph has been sought diligently ever since the instrument that made Detective Burns famous was placed upon the market eight years ago. In his cases in court Burns has been forced up to the present to submit stenographic notes, the authenticity of which he has had to prove.

For eight years Mr. Turner worked on the invention. For seven and a half of them he sought to connect the diaphragm of the dictograph directly to the needle of a phonographic roll, but got no results. Four weeks ago he began experimenting with an air cushion between the diaphragm and the needle, instead of a direct connection, and at once obtained a full and natural reproduction of the voice.

Mr. Turner explained that the new invention, as applied to business, means that it is now possible for a business man to sit at his desk and dictate his letters in his ordinary tone of voice, and have them taken down on phonographic rolls sisted, was that now recognized in the transmission of conversations by telephone.

"There's a chance here," said Mr. Turner, "for newspapers to eliminate the time loss between big convention halls and their offices. It could manufacture in the office over this wire phonographic rolls of the speeches just as they were made. Type-setters, working from these rolls, could pass the matter almost directly from the speaker to the printing presses."

In detective work, Mr. Turner said that the absence of the self-recording feature had proved an almost insurmountable difficulty. It had been necessary to make the instruments so that two detectives instead of one could listen to what was being repeated by the dictograph. In some court cases the dictograph's evidence had been thrown out, because a single detective's transcription of the record was thought to be hardly reliable enough for a conviction. "But now the judge can listen to the phonograph in the courtroom," said Mr. Turner, "and he can tell each man's natural voice. The dictograph will identify each man who has spoken in a room where it has been at work,"

In detective work, the dictograph would be equipped both with listening

MECHANICAL DRAWING

P. LEROY FLANSBURG L. BONVOULOIR

WORKING DRAWINGS AND ASSEMBLIES

When a piece of machinery is to be designed, a rough *lay-out* of the machine is first made, and then the dimensions and proportions of the various parts are calculated. In Fig. 1 is shown the *lay-out* of a cam arrangement consisting of a plate cam and a cylindrical cam. The cylindrical cam oscillates a disc through an angle of 90 degrees. In the periphery of the disc are two ¾ in. holes 90 degrees apart. The plate cam raises and lowers a lever arm to which is attached a plunger, and at certain intervals this plunger drops into one of the two holes. The relative motion of the two cams is such that when the plunger is entering or leaving one of the holes, the disc remains stationary, while when the disc is moving

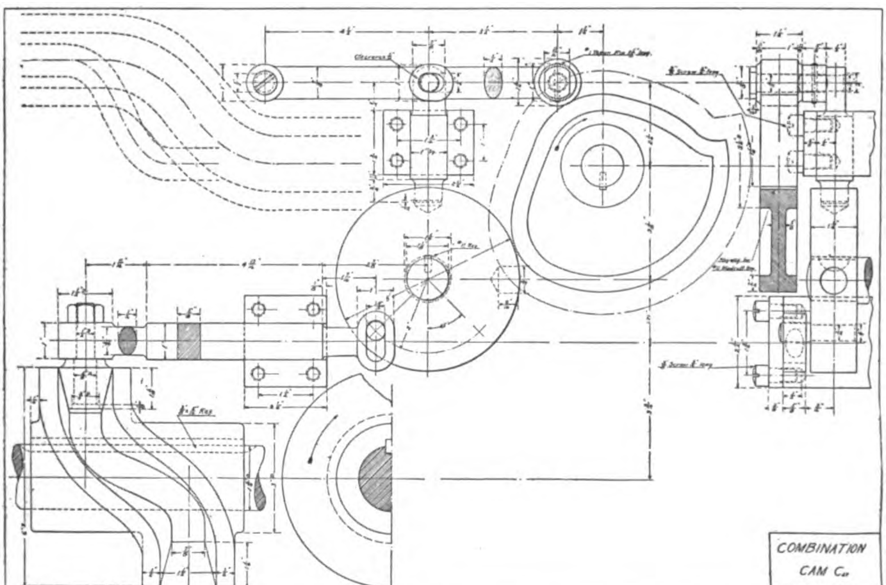


Fig. 1

necessary in such a drawing to show sections or indicate dimensions, as such a *lay-out* is usually made to a definite scale, and the dimensions may be scaled off directly from the drawing.

One of the chief purposes of a *lay-out* is to insure the proper arrangement of the various parts so that there may be no overlapping of any kind or any interference of one part with another. It is not usually necessary to show as complete a drawing as this one, and as a rule only the outlines are shown. Where one portion of the mechanism travels a considerable distance during its cycle of operation, it is best to show with full lines one of the extreme positions of the mechanism, and to indicate with dotted

checking up the proportions and operations of the various parts, the drawings are next passed on to a draftsman who draws out to scale the various parts of the mechanism. Such a draftsman is known as a *detailer*. His duty is to make separate drawings of each individual part, giving full dimensions and instructions on the drawing, so that the pattern-maker or the machinist may work entirely from these drawings without any verbal instructions from the designing room. *Detail drawings* and sketches were shown in the April issue of the ELECTRICIAN AND MECHANIC. These drawings were made from actual machines, but where a new machine is being designed exactly similar drawings

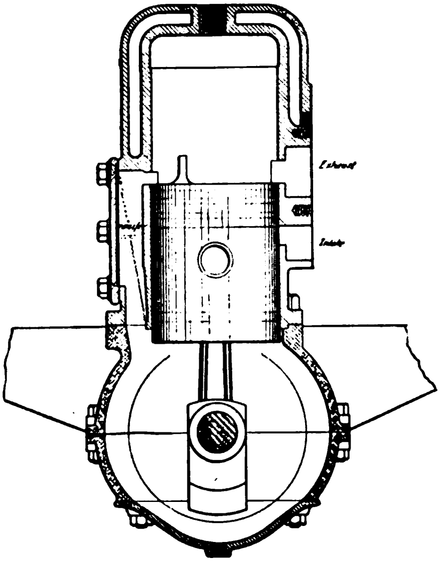


Fig. 2

are made from the *lay-out*, and these are the ones which the pattern-maker and the machinist receive.

After the detail drawings have been completed, an *assembly* drawing is made information which is necessary to clearly define both the shape and arrangement of every part of each piece of the mechanism. Frequently, however, these three views are not sufficient to give complete information regarding the construction and arrangement of the parts, and in such cases, it is necessary to make a representation of the object as it would appear if cut by a plane, or in some cases a detailed view of one or more parts must be given. Where a section is taken through the object, the cross-hatching of the section indicates both the materials used and where the different pieces of the same material are in contact. The principle of sectioning was carefully treated in a previous article and the U.S. Standard style of sectioning was given. When possible an *assembly drawing* should be made full size, but where this is either impossible or impractical, the drawing should be made so many inches to the foot and the scale used indicated on the drawing in the following manner: namely, 3 in. = 1 ft., or one-quarter size. The title of the *assembly* is always placed in the lower right-hand corner of the drawing and inside of the margin line. It includes the name of the machine or mechanism; the name of the special part which the *assembly* shows; the scale to which the drawing is made; the date of completion of the drawing; and the draftsman's name or initials. With *assemblies* as with other drawings, the inking of the drawing should never be begun until the penciling is completed. Usually, however, the penciling is done on ordinary detail paper and the tracing is made from the pencil drawing. Copies of the drawing may then be made by the ordinary blueprint process and the tracing need not leave the drawing room, where it is filed away for reference.

If it is desired to make but one view ... machine, it is often found

hatching indicates the material of which the different parts are made, and as the drawing is made to scale, no dimensions are shown. It should be noticed that when taking a section through such a piece of machinery, the section is taken through a diameter, and a cylindrical surface within may be cut by the section or not, at the discretion of the draftsman. Where several similar parts are united in one *assembly*, a section taken through one of these parts may cut all interior mechanism, a section taken through another of these parts may cut but a portion of the object, while the remaining parts may be shown in full. This is exemplified in Fig. 3.

which covers the cam-shaft is removed. The drawing shows one of the valves lifted to its maximum height and the other valve seated. The fourth cylinder and its valve mechanism are shown complete. The scale of the original drawing was 6 in. = 1 ft., but as the drawing had to be reduced before reproduction, the scale was omitted.

Blueprints of the *assembly* drawing are sent to the assembling department and are used as a guide in erecting the machine. They are often used by salesmen or in catalogs to describe and explain the workings and construction of the machine.

Assembly drawings are usually the last things treated under the title of Mechanical Drawing. It was the original intention of the authors to include Gear Design, Cam Design and Perspective in this course, but as the work progressed it was realized that these subjects were worthy of separate attention and it was not considered advisable to include them. As a last word to the student in Mechanical Drawing we would say that the only way to learn drawing is by doing original work. The making of tracings is but a poor substitute for original work, and is not worthy of the attention which it is usually given. Anyone with ordinary intelligence and some slight experience

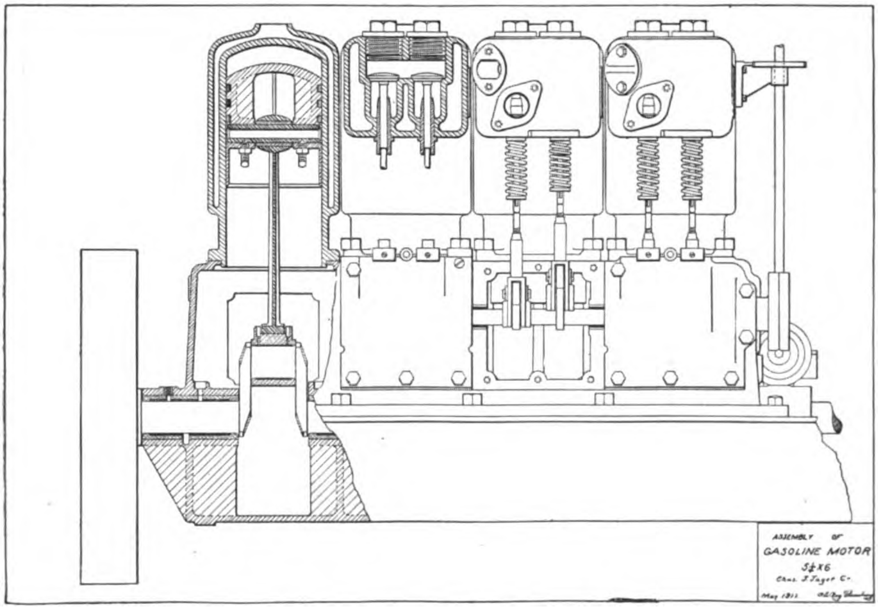


Fig. 3

Fig. 3 is the assembly of a gasoline motor set up ready to run. The first cylinder and a portion of the crank-case are cut by a section-plane. This plane passes directly through the piston, piston-rings, piston-rods and crank-shaft, and therefore clearly shows the various materials used. It should be noticed that the section is so taken that the entire valve mechanism for this cylinder is eliminated from the drawing. The valve mechanism for the second cylinder is cut by a section-plane, and the valve rods and springs are not shown. This section shows the valves and the interior of the valve-chamber. The third cylinder is not cut by a section, but the plate

(*Continued on page* 392)

METALLIC TUNGSTEN AND SOME OF ITS APPLICATIONS*

Tungsten does not occur as such in nature; but in the form of compounds it is pretty well distributed. The most important ores are sheelite, or calcium tungstate, and wolframite, or iron-manganese tungstate. The principal source of the ore at this time in this country is Boulder County, Col.

From the ore it is a simple matter to get the yellow oxide (trioxide) of tungsten. And the trioxide may be reduced in various ways, as with hydrogen, zinc, and carbon, to metallic tungsten. The product so obtained is in the shape of a powder, ranging in color from gray to black, depending upon the fineness of its state of subdivision.

Owing to its very high melting-point, it was for a long time impossible to get the pure powdered metal into the form of a dense coherent homogeneous mass. Two Austrians, Messrs. Just and Hanaman, working in Vienna, finally succeeded, however, in producing the pure metal in this condition and in a filamentary form, and by using it as an incandescent filament became the inventors of the tungsten lamp.

PHYSICAL PROPERTIES

Wrought tungsten is a bright, steel-colored metal, having the same density as gold—19.3. (This varies somewhat with the amount of mechanical working which the specimen has had.) The strength and pliability both increase with the amount of mechanical working. The fracture may be very coarsely crystalline, or it may resemble that of a very fine-grained tool-steel, or it may be fibrous and silky in appearance, or it may lie anywhere between these extremes, the appearance in each case depending upon the chemical purity and upon the preceding thermal and mechanical treatment and quenching. Similarly, tungsten containing carbon is not appreciably affected by quenching. The hardness imparted by working may be entirely removed by carrying the metal to white heat. The ductility is extreme, as is shown by the fact that wire only 0.0006 in. (0.0152 mm.) in diameter is now produced in large quantity. Tungsten is non-magnetic. The electrical resistivity at 25 degrees C., expressed in microhms per centimeter cube, is 6.2 for the hard-drawn wire and 5.0 for the same annealed. The corresponding data for annealed copper and annealed platinum are 1.87 and 11.1 respectively. The temperature coefficient of electrical resistivity per degree between 0 degree and 170 degrees C., is 0.0051. Assuming the Franz-Wiedemann law to hold for the relation of heat to electrical conductivity, we may calculate the heat conductivity of annealed wrought tungsten to be 0.37 times that of copper and 2.2 times that of platinum. The coefficient of heat expansion per degree, from 20 degrees to 100 degrees C., is 336 x 10^{8}8, which is about 0.26 that of platinum.

CHEMICAL PROPERITIES

Wrought tungsten does not tarnish upon standing in the air. Upon heating it to a temperature of 300 or 400 degrees, however, it oxidizes superficially and turns blue just as steel does. At bright red heat the oxide volatilizes, and the metal wastes away more or less rapidly, depending upon the temperature. It is quite resistant to the action of most acids, being entirely unaffected at room temperature by either dilute or concentrated hydrofluoric, hydrochloric, nitric, and sulphuric acids. With aqua regia at room temperature the action is very slight. At a higher temperature, 110

of sulphuric and chromic acids, but the metal dissolves rapidly in a mixture of hydrofluoric and nitric acids. An aqueous solution of caustic potash has no effect on wrought tungsten, but the fused salt does attack the metal slowly. In aqueous solutions of sodium or potassium carbonate or mixtures of the two, tungsten dissolves slowly, the action being considerably hastened by the addition of potassium nitrate.

ELECTRICAL CONTACTS OF WROUGHT TUNGSTEN

Under the conditions pertaining in many electrical make-and-break devices, as in magnetos, spark-coils, voltage regulators, railway signal relays, telegraph and telephone relays, telegraph sending keys, etc., wrought tungsten has proved to be far superior to platinum or platinum-iridium for the contact points.

This was not in any sense an obvious application, for tungsten is not like platinum, a difficultly oxidizable metal. It might well have been assumed that under the heat of the minute arcs which form when the contacts are separated, the tungsten would oxidize at the points where arcing has taken place, and that non-conducting layers would thus be formed which would produce a high and variable contact resistance. In fact, our first experiments bore out this theory. But subsequent work showed that the difficulty in these early experiments came from the fact that, at the time, we were unable to make a good thermal and electrical joint between the tungsten and the contact-carrying members. With the attainment of a good conducting joint, our results changed completely. The contacts no longer rose to the same high temperature, and the oxidization decreased to little or nothing. Moreover, in case there was any oxidization, it was to the lower and electrically conducting oxides.

Tungsten contacts wear longer than those of platinum or platinum-iridium. This is doubtless largely to the lower vapor pressure. At temperatures at which platinum volatilizes badly, tungsten has a very low vapor pressure. Besides this, the heat conductivity of tungsten is more than twice that of platinum, and as a result, the contact faces do not rise to the same high temperature. (In comparison with platinum-iridium alloys, the ratio of heat conductivities is still more favorable to tungsten.) In connection with the life of contacts, another important consideration is that of hardness. Tungsten is so hard that it does not batter down at all under the continual hammering which the contacts get in service.

Tungsten contacts show less tendency to stick than do contacts of platinum or platinum-iridium. This is to be attributed in part to the higher melting-point of tungsten. There seems to be another factor here, however, for while we are able, by proper manipulation, securely to weld together two pieces of platinum at a temperature considerably below the melting-point, it has not as yet been possible, except by actual fusion, to produce anything more than a very weak adhesion between two pieces of tungsten.

One minor and unexpected advantage connected with the use of tungsten contacts consists in the fact that they seem less sensitive to the accidental presence of oil than do platinum contacts.

Allusion has already been made to the difficulty at first experienced in producing satisfactory thermal contact between tungsten and the metal comprising the contact-carrying member. This was due to the fact that tungsten can not be satisfactorily soldered by any of the ordinary processes. This difficulty has been overcome in the following way: The little disc of tungsten, which is to serve as contact-point, is attached by means of copper to the head of an iron tack. Copper does not alloy with tungsten; but, under suitable conditions, it wets it, and then adheres firmly. This gives a joint of high thermal and electrical conductivity between the tungsten and the head of the iron tack. The shank of the tack is then either pressed in, or brazed, or riveted to the contact-carrying member.

WROUGHT TUNGSTEN IN X-RAY TUBE

This has proved to be, both from the scientific and practical points of view, an exceptionally interesting application.

Until recently platinum has been almost universally regarded as the best target material, and it has so long held undisputed sway in this field that the Roentgen-ray worker has come to look

upon its limitations as inherent in the Roentgen tube.

With the advent of dense, forged pieces of pure malleable tungsten, the possibilities of the Roentgen tube are greatly extended.

The desiderata in a material to be used as the anticathode or target are the following:

1. High specific gravity.
2. High melting point.
3. High heat conductivity.
4. Low vapor pressure at high temperature.

The reasons why the above qualities are desirable follow readily from a brief consideration of the theory of Roentgen ray production.

From the concave cathode, electrically-charged particles—the electrons—are shot out at high velocity in a direction normal to the surface. The paths of these particles converge, and the target is placed at or near the point of strongest convergence—the focus point. When the electron meets an obstruction, as the target, its velocity is reduced, and the denser the target the more rapid is the deceleration. The more rapid the deceleration, the greater is the amplitude of the electromagnetic pulse—the Roentgen-ray—sent out. Here, then, is a need for high specific gravity: that of forged tungsten is but little less than that of platinum.

In modern Roentgen-ray practice, powerful apparatus, running sometimes to a capacity of 10, and even 15 kw., is used to excite the tube. A considerable part (perhaps as much as one-third) of the energy delivered to the tube is transformed into heat at the point where the cathode rays bombard the target. Where platinum is used it has been found necessary, to prevent melting, to place the target tube has been increased by water-cooling the platinum or by using as a target a large mass of copper having a very thin platinum face. But the limit, although raised by these artifices, has still been the melting-point of the platinum.

Tungsten has a much higher melting-point (3,000 degrees C., as against 1,755 degrees for platinum), and so, even with sharp focusing of the cathode rays on the target, permits the use of more energy than has hitherto been possible, for the high temperature to which it can run enables it to radiate more heat, and its better heat conductivity permits a more rapid flow of heat from the focus-spot to the surrounding metal.

Stability of vacuum in a Roentgen tube is of the utmost importance, as the character of the rays is so largely determined by the vacuum. Metal, which, under the influence of the high temperature, vaporizes from the target, condenses on the glass in finely-divided form and absorbs relatively large amounts of gas, thus changing the vacuum. At high temperatures tungsten vaporizes least of all the metals.

Two distinct types of tungsten targets are being tried out experimentally in competition with one another.

The first of these consists of a heavy copper block with a disc of wrought tungsten attached to the face. This is similar to the platinum targets which have been in use for some years. The function of the copper is simply to conduct heat away from the tungsten and to act as a heat storage reservoir. In this latter capacity it is much more effective than would at first seem possible, owing to the fact that while the rate of energy input is high, the time is correspondingly short, a single excitation of the tube lasting for perhaps only half a second. ... that it would

ELECTRICITY AND PURE DRINKING WATER IN THE CITIES

FELIX J. KOCH

Water-works engineers, as well as students of municipal sanitation, the world over, are watching with no little interest the development of a remarkable application of electricity, obtained without cost, to the municipal filtration system of what Lincoln Steffens termed the "worst-governed city in America"; materially reducing the cost of such filtration and thus making it by so much within the reach of poorer municipalities.

In the winter-time, in order to insure

the purity of the water, chloride of lime is used. A solution is really made, consisting as a rule of six-one-hundredths of a millionth part in the bulk. At present this chloride of lime, for one day's consumption, costs about $10; multiplying this by the number of days of the year, and keeping in mind, too, that with the natural growth of popula-

sum, the engineers have now found a way of using the electricity generated here—as at most filter-plants—by the water, in flowing from the settling-basins to the coagulating basins. This means that they will practically get their electricity free.

In utilizing it they have a special "battery"—as it is called—into which salted-water flows. The electrical current is then passed through that salt water so as to produce all the chlorine that need be used to sterilize the city's drinking-water.

While to date there have been made only large-size laboratory tests on the subject, the city is now to build a new house devoted to this end, where it will practically cost Cincinnati nothing to make her chlorine, except for the salt in the water.

HALL STAND

The design for a Hall Stand, shown at Fig. 1, is very simple in construction, yet artistic in appearance. There are no difficult joints to be made, and any-one with only a little knowledge of wood-working tools should be able to make a satisfactory piece of work.

The side and front elevation is given at Figs. 2 and 3, and it will be seen that the widest part is 3 ft. 2 in., the height 6 ft. 3 in., and the depth or amount of projection from the wall, 10⅛ in. There are six hooks, four screwed underneath the top, and two in front. A beveled edge mirror is fitted in front and a box, 10¾ x 9⅛ x 5⅜ in. inside measurements, divides the space for umbrellas, etc. Tin trays are fitted in the bottom board.

It will be as well to make a commencement with the sides, as shown at Fig. 2, but it will be necessary first of all to cut up the wood in the most economical manner.

We have four 10 ft. lengths, and this gives us a little over in the event of a mishap, one length should be divided up as shown at Fig. 5. This will give us two 6 ft. 3¾ in. lengths, two 3 ft. 9 in. lengths, and leave sufficient to make the sides, base, etc., of box. Two more lengths should be cut up into lengths of 6 ft. 3¾ in. and 3 ft. 2 in., the longer lengths forming the sides, as shown at Fig. 6, and waste portion providing lengths of 3 in. wood for rails, as shown, the shorter lengths form top and bottom boards. The remaining length, shown at Fig. 7, provides the two middle rails with waste portions, which may be used up as required.

It will be seen at Fig. 2, that the sides are cut out to 2 in. wide for a considerable portion of the length, the widest part being 9¾ in. Plane up both pieces to this width, and ⅝ in. thick, and then mark out the curves to a radius of 7¾ in. If a compass or bow-saw is at hand saw to the curves; if not bore a series of holes close together, and then use a hand-saw on the straight part. As the sides are sloping when in position, it will be necessary when spokeshaving the curves smooth, to allow for this, so that the front corners are horizontal when in position.

The back, Fig. 4, should now be made. *A* and *B* are 6 ft. 3¾ in. long, *C* and *D* 3 ft. 9 in., *E* 3 ft. 2¼ in., *F* 3 ft. 1¾ in., *G* 2 ft. 9½ in., *H* 2 ft. 4 in., all 3 in. wide by ⅝ in. thick, with the exception of *F*, which is 6 in. wide. The joints, without exception, are the ordinary lapped halving shown at Fig. 8, those at *K* being shown at Fig. 9. To avoid showing the end of the joint an alternative joint is shown at Fig. 10, this taking a little more time, but is not at all difficult. When the back is jointed up, glue all the joints and screw them from the back with ½ in. screws, two in each joint, placed diagonally. The sides may now be screwed on with 1⅜ in. screws, as shown by the letter *S* at Fig. 2; the top also may be screwed in position, counter-sinking the heads to avoid having a projection.

We have now to fix in the shaped front *M*, shown at Fig. 7; this should be carefully fitted, and screwed in from the sides, as shown. The bottom front rail may also be fitted in and screwed in position. The sides of the box may be fitted, and can be nailed with oval brads from front and back, the bottom being fitted and nailed in on all sides.

The top of the box should be 13 in. long and 8½ in. wide, with two 2½ x ⅝ in. lengths of wood screwed on underneath, as shown at Fig. 11. It should be hinged with 1¼ in. brass butts to a 1¾ in. wide length, and the top beveled off, as shown at the enlarged detail, Fig. 12. The bottom board may be fitted in, and screwed or nailed from the top, previously cutting out a hole at each end 1½ in. away from edges, and 11 in. long.

The mirror should be fitted in space, 15 in. x 6 in., with a rebate formed by beading made as shown at Fig. 13, and fixed on the edges, as shown at Fig. 14. A thin backing should be tacked in to prevent damage to the back of mirror.

The trays, Fig. 15, may be easily made of ordinary tinned iron, cut out at the corners, as shown at Fig. 16. The inside dotted oblong should be 11 x 7 in. the next dotted line should be 1 in. outside, and the outside the same distance outside again. A small portion is allowed for overlapping, and the outside inch border is mitered. The corners

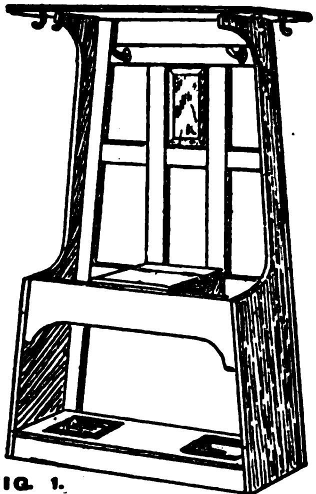


FIG. 1.

IDEAL HOUSE FURNITURE.

I—HALL STAND.

1. Completed Stand.
2 and 3. Elevation.
4. Back.
5, 6, and 7. Method of planning out timber.
8 and 9. Lapped joints.
10. Alternative form of joint.
11. Lid of box.
12. Detail of corner of lid
13. Bead.
14. Section through mirror.
15. Tray.
16. Method of setting out corners of tray.

MATERIALS REQUIRED.

Four 10-ft. lengths of 10 in. by ¾ in. wood.
One piece of bevelled-edge mirror, 15 in. by 6 in.
One pair of 1¼ in. brass butt hinges.
Two coat and hat hooks.
Four wardrobe hooks.
One piece of tinned iron. No. 22 S.W.G., 18 in. by 15 in.
Screws, nails, stain, &c.

FIG. 5.

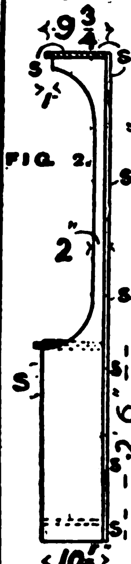


FIG. 2.

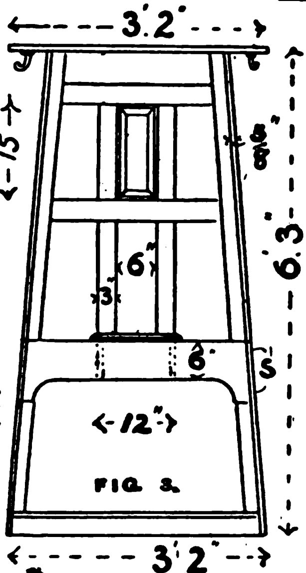


FIG. 3.

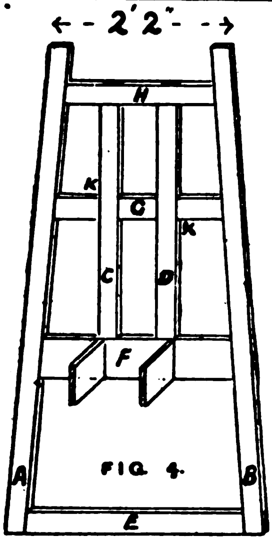


FIG. 4.

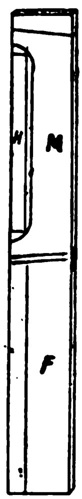


FIG. 7

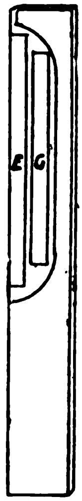


FIG. 6.

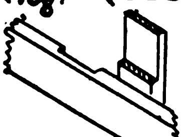


FIG. 8.

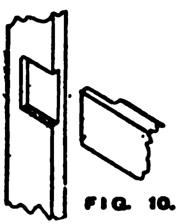


FIG. 10.

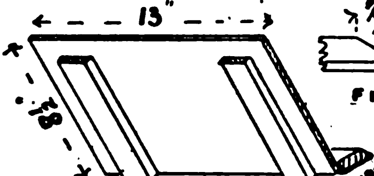


FIG. 11.

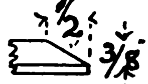


FIG. 12.

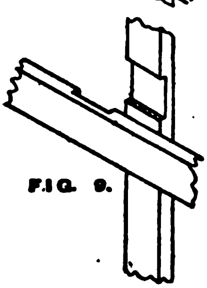


FIG. 9.

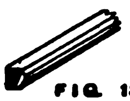


FIG. 13.

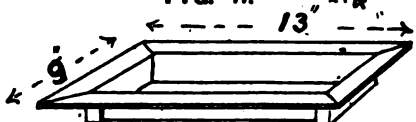


FIG. 15.

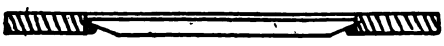


FIG. 14.

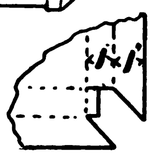


FIG. 16.

may be beaten up with a mallet on the flat face of an iron, and if just flushed with solder, they will be quite water-tight.

All holes should be filled in with stopping made of sawdust and glue before finishing off, and a good surface given with glasspaper before staining.

There are several methods of staining suitable, either water stain, size and varnish: Spirit stain and varnish combined; or a good walnut, "egg-shell," finish may be imparted by coating with turpentine, darkened by means of Brunswick black.—*Hobbies.*

WIRELESS FOR HOURS, LONGITUDE AND LATITUDE

DR. LEONARD KEENE HIRSHBERG A.B., M.A., M.D. (JOHNS HOPKINS)

Mr. E. A. Fath of the Smith Astronomical Observatory, Beloit College, Beloit, Wisconsin, endorses the use of radio-telegraphic signals as an accurate mode of transmitting seconds, minutes, hours, and the determinations of longitude. Although Dr. Fath's suggestion is by no means new, the weight of an astronomer's confirmation of this idea, which has been in use on the Eiffel Tower station in Paris and other stations such as the Norddeutch Station in Germany, will hasten the general adoption of the scheme.

Shipping in the North Sea, the English Channel, the Atlantic Ocean and elsewhere, will be made much more valuable if this plan is extended. In America the radio-telegraphic time service is about to be established for the first time as an accurate means of setting the time by electric waves. The plan suggested by Professor C. A. Culver, of the department of physics of Beloit college, is the one that meets with serious approval. He and Dr. Fath went over the ground with great detail and weighed the various plans before selecting the system they propose.

A standard time clock is connected in the office with a system of relays by wire. These relays are connected with the wireless apparatus, a radio-transmitting equipment with an induction coil at the left which was used as an open core transformer of the high tension type. The ordinary alternating current from an electric lighting circuit was used; it had a frequency of sixty cycles and the usual voltage of 110. The transformer changed this voltage to about 30,000, which charged a high tension condenser on the right side of the apparatus.

This condenser discharged through the customary spark gap and the helix in the center, which should be an oscillation transformer. This last device changed the frequency from sixty to several hundred thousand per second. The aerial arrangements, from which the electric waves were radiated into space, were 400 feet high and of course connected up with the oscillation transformer.

Thus, the standard time clock in an office or elsewhere can be made to control the current which actuates the high tension transformer and therefore the electric waves which are shot out. With every tick of the clock, a series of electric waves is shot forth into the circumambient atmosphere, and each train of waves is received as a single dot at the imparting station. Dr. Fath sends out each day these signals. "At 2.55 p.m. the clock is switched into the circuit and each beat sends out into space a group of ether waves. The 59th beat each minute is omitted up to 2.59:50. There is then an interval of ten seconds followed by a single beat. This beat marks 3.00:00 p.m. and may be considered the essential signal."

All of this is so simple that any schoolboy who is in the habit of using a wireless outfit may put it easily into practice.

Bubbles will last for hours and may be blown to exceed 2 ft. in diameter with the following solution: 1 part oleate of soda, 50 parts distilled or rain water (parts by weight). Mix thoroughly and leave one day to clear, using only the clear solution. The tenacity of the film is much increased by adding pure glycerine, not exceeding 2 parts glycerine to 3 parts clear solution.

EDISON TELLS HOW HIS MOTION PICTURES TALK

Thomas A. Edison, whose inventions have, for more than a third of a century, held the world breathless and made the "Tales of the Arabian Knights" seem commonplace by comparison, has passed his own wonder record of electric light, phonograph, fluoroscope, kinetescope and countless other marvels by his latest magical invention—the kinetephone.

Youngest of all the wonderful children of that wonderful brain, but requiring the most of mechanical ingenuity, the most of long sustained and determined effort, it seems destined most of all to preserve for him his title of "The Wizard of Menlo Park."

What is a kinetephone anyhow? That was the question that bothered your correspondent, hearing vague rumors of this new Edison wonder. He knew it had something to do with "making the movies talk," but he had seen of recent years many pitiable failures of phonographic and vocal accessories striving to accomplish this for these same "movies." He had seen the shot fired and the girl fall, heard a belated phonograph crack like a pistol and let out a feminine shriek. He had seen—

But this kinetephone? This was Edison—and that was different.

So straightway he betook himself to Mr. Edison for first-hand information. He found the inventor not the abstracted, intellectual giant, with head in distant clouds, as pictured in popular fancy. The intellectual giant was there—but so far from being in the distant clouds, he was a most pleasant and hospitable human being. His genial countenance, with the smile of humor ever poised to spring rippling forth, reminded one much of Oliver Wendell Holmes, in his best "Breakfast Table" mood. His greeting was most cordial.

"Oh, yes; I've plenty of time to see you," was his cheery reply to a request for information. "What is it you wish to know?"

"About this new invention of yours, the kinetephone," replied the visitor.

"Come along with me," was the wizard's hospitable interruption. And leaving his 200 assistants busily delving in all manner of scientific problems, he led the way to a large building adjacent, in one corner of which was a spacious chamber, proof against both sound and light.

"This is my experimental theatre," he explained, as he switched on the electric lights. It was much like the type of motion-picture theatre known to every person in the land who is old enough to walk—about 40 ft. wide and twice as long. At the far end was the broad white screen; in the rear was the motion-picture machine. Folding chairs took the place of ordinary seats; for in his numberless experiments Mr. Edison must have plenty of room.

NOT METALLIC

"But what is the kernel of the invention?" queried the visitor, too curious to await developments.

"It is the absolute synchronization of the movements in the motion pictures with the appropriate sounds," replied the wizard, as the lights went out, "and that, whether it be the human voice or—

Just then there burst upon the ear the opening strains of "Il Trovatore." Not in the harsh metallic timbre of the phonograph, but clean, clear and resonant, as from an orchestra, many toned and perfectly balanced. The next instant there flashed upon the screen the opening scene of the great opera. From the crowded stage came the full-throated voices of the singers, blended in perfect harmony with the orchestra.

Rising, swelling and sinking in cadence, all in faultless rhythm with every motion and gesture of those picture singers, the mingled music of voice and orchestra floated forth from that picture stage in an illusion that held the visitor spellbound. Not a false or harsh note! Not a single ill-timed movement, nor a belated gesture from a single one of all that lifelike throng, gathered there on the phantom stage; but all in perfect keeping—perfect beyond perfection—with the strains of voices and instruments.

"Marvelous?" whispered the visitor to himself. "I'll have to get something stronger than that weak word to tell this tale."

What struck him as strangest as he sat there trying to collect his scattered wits while the great opera proceeded to its tragic end, was the magical modulation

of the sounds. The absence of any rasping, phonographic metalism was wonderful enough. The perfect coincidence of gesture, with the appropriate words, was marvelous, indeed. But by what magic was it that the voices of the singers were trained so deliciously as to be in keeping with every position they took, whether up—or down—stage; whether with backs or faces to the front?

The modulation of melody and harmony, of voices and orchestra, so different from the screeching of some phonographs, with their dull, flat monotony of timbre, were reproduced with an exactness and reality worthy of a finished opera troupe.

THE ALERT INVENTOR

Yes, the illusion was perfect; the visitor was not listening to a phonograph; he was not looking at a "movie." He was hearing and seeing the greatest of emotional operas, rendered by the living flesh and blood of singers and musicians and not some subtle combination of dead metal and celluloid and dull wax, galvanized by electricity into phantom life.

Leonora and Manrico were there alive, agonizingly alive, sobbing out their woes in exquisite melody, buoyed by the harmonies of an orchestra of artists. The writer's breath came short, as does that of any music lover in such case, his fingers clutched the arms of his chair. And then—

And then, from the tail of his eye he caught a glimpse of Mr. Edison and was back to earth in an instant! The great inventor was not watching the stage at all. His gaze was fixed upon his visitor, observing his every movement, his every expression of interest and astonishment—truly, the man of practical science, noting

far back, remember—the quavering tone of Manrico, with its piteous "Ah che la morte," distant, soft, almost a whispering sigh of melody.

Then, as the tone swelled, the hearer could see, in his mind's eye, the unfortunate lover, groping his way through the darkness toward the sound of Leonora's voice. Louder, nearer it grew until, as his face appeared at the grating of the dungeon, it rang forth in all its volume and filled the theatre with its despairing farewell—and just then it stopped and the lights flashed up, and there was nothing but an innocent white screen, which none the less seemed to wear a very human expression of humor on its blank surface as the visitor caught his breath with an ejaculatory "Oh!"

It was like being jerked headlong into another world, this sudden transition from the company of the fourteenth century "troubador" to a seat beside a twentieth century scientist in one of his experimental departments!

"Well I declare!" exclaimed the visitor; it was all he could think to say. "It's the most wonderful thing I——"

A SIMPLE DEMONSTRATION

"Ladies and gentlemen," interrupted a smooth, trained voice as the lights blinked out. The visitor turned his gaze from Mr. Edison to see what newcomer had broken in upon his rhapsody. There, on the stage, stood a man in evening dress, pointing to a machine set upon a table beside him.

"I desire to explain briefly to you the mechanism of the kinetephone," continued the man on the stage—well, on the screen then, but it looked just like a lecture stage. Again the visitor gasped at the perfect realism of it all. The opera had been something wonderful; but then

There was something uncanny about this everyday human being, so real, and yet so unreal; not even a painting, but just a fleeting will-o'-the-wisp of an image. Farther over the visitor leaned, rapt—and then he caught a glimpse of his wizard host, watching him with that subtle, quizzical smile—the smile of the "Autocrat of the Breakfast Table" playing about his lips and sparkling in his eyes.

As he turned again to the stage, the lecturer dropped a china plate. "Crash!" it struck the stage and the fragments clattered merrily as they danced across the floor! The visitor jumped. He couldn't help it; he'd broken plates himself!

Then followed the blowing of horns and whistles, together with piano, violin and vocal solos, all in perfect coincidence of movement and sound.

Last of all two collie dogs romped on the stage and set up a most lugubrious howling. An hour before these dogs would have set that visitor's heart tripping in excited amazement. But he was beyond that now; he had exhausted all his stock of astonishment.

"Bring on Michael and his archangel!" he sighed to himself. "I'm ready for anything now!"

RUN BY A BOY

But here the lights flashed up again and the marvelous show was over. The visitor drew a long breath. He looked at the dead appliances that had produced such astounding results. He was beyond rhapsody now.

"It must take a most accomplished and experienced scientist to operate this kinetephone," he remarked to Mr. Edison, coming back with relief to the commonplace after his breathless journey into wonderland.

The smile rippled full-tide over the features of the wizard.

"Here, Bobbie!" he called to a boy standing by the motion-picture machine. The boy came up.

"This boy, just turned 16, who is but a two-weeks' apprentice at the work," remarked Mr. Edison, "operated the kinetephone throughout the entire exhibition you just witnessed. Anyone who can operate an ordinary motion-picture machine can operate the kinetephone."

"But, tell me this, please, Mr. Edison," explained the visitor, the pent-up question now bubbling to the surface as they gained the open air. "How do you make the phonograph sound so unscreeching and life-like? And how do you make it coincide so exactly with the motions and gestures of the persons as they talk and move in the motion pictures? And how do you modulate the tones so perfectly? And how do you ever manage to get a phonograph that would take in a whole opera cast like that, when everyone knows that when folks sing or talk into a phonograph, they crowd close around the receiving horn as if they were all looking into a hole? And how——"

"Come into my office," said the wizard, good-naturedly, "and I'll explain it all to you. Oh, yes, I've plenty of time."

"I've been working on the kinetephone for twenty-five years," he resumed, when they were comfortably seated in his private office. "At least, I began to do some desultory work upon it that long ago. For six years I have been at it, day and night. It was my aim, from the beginning so to perfect motion pictures—not 'moving' pictures, by the way, for the picture stays in the same spot, only the objects within it move—so to perfect motion pictures that they would exactly simulate the stage and indeed real life, in words and sounds as well as action.

"I did not bring out the motion picture until I was able to show perfectly all that took place on the stage. I decided then to give the public the benefit of what I had accomplished. That I was right in doing so is evidenced by statistics, which show that 12,000,000 persons visit the motion pictures daily.

MECHANISM SIMPLE

"I continued, however, to work on my original problem until I reached my goal—which I have now done. When not only the actor's movements, but also his words can be reproduced, I believe the popularity of motion pictures will increase still more. No, there is no complicated mechanism added to the present motion-picture machine to create the kinetephone. It is merely a perfect combination of that machine with the perfected phonograph.

"Now, there were several great difficulties confronting the perfection of the kinetephone. First, to synchronize both

motion-picture machine and phonograph so that each word spoken by the actor on the screen should be exactly contemporaneous with his appropriate action. This presented several difficulties; ordinarily the speaker must talk right into the horn of the recording phonograph. But I found that I must have a recording medium of sufficient sensitiveness to make an accurate record at a distance of 40 ft.; otherwise, the recording phonograph would show in the motion picture.

"After a number of experiments, I perfected a cylinder which would make such record. It was of wax; soft wax; so soft that the slightest sound would make an impression upon it. It was almost as soft as butter. Then I placed the motion-picture machine and the phonograph with the wax cylinder side by side, and connected the moving parts to the same gearing with identically the same gearing. This, you see, insured absolute synchronism of voice or sound, with the appropriate action.

"When the actors move and talk upon the stage both machines record what occurs both as to movement and sound, at identically the same instant. A notch at the starting point of both the recording film and the wax cylinder shows the beginning of both records.

"Why, that seems very simple, now!" exclaimed the visitor. Then he paused: "Columbus and the egg!" he murmured to himself.

CATCHES FAINTEST SOUNDS

"And then," continued the wizard. "I found I had to face a still more difficult problem. That arose from the fact that the volume of sound, as recorded by a phonograph, vastly increases or diminishes with the proximity or distance of the speaker from the recording instrument. In playing their parts actors extreme softness of the wax-recording cylinder enabled me to catch the faintest sounds. In order to diminsh the sound, when the actors were speaking nearer the phonograph, I had the horn attached to the recording phonograph so made that its size could be increased or diminished by the operator. Of course, you know that the larger the flaring sides of the horn the greater the number of sound waves it will receive, and consequently transmit for record on the phonograph; on the other hand, the smaller the horn, the less sound it receives.

"How did I get a horn that could be made big or little at will? Why, by making the sides open or close by the simple movement of a lever. Here is one." And Mr. Edison exhibited this novel adjunct to his success. It was constructed much on the lines of the old-fashioned accordion, once much affected by rural serenaders; its sides opened out and closed in the same manner.

"Well, I declare," exclaimed the visitor, "that's simple, isn't it! Columbus and the egg again!" he added.

"Next," went on the wizard, "I realized that in order to perfectly simulate the human voice, or, indeed, any sound—it must be reproduced without the harsh, metallic rasping of the ordinary phonograph. This is an entirely separate invention, but I was stimulated to it by my desire to perfect the kinetephone.

NEW STYLE NEEDLE

"The metallic sound was wholly eliminated by the use of a diamond-shaped needle; this, you see," and here Mr. Edison held a needle for inspection, "is broad at its base, tapering gradually down to a point. Of course, the greater the volume of sound the farther the needle was pushed into the wax cylinder, and hence the broader the impression made. With this style of needle it is the breadth of

tions of depth in the wax, and not, as with the old needle, with those of the breadth. This, I find, does away entirely with the metallic rasping, as you yourself have lately witnessed.

"I will mention here that I made a vast number of experiments before I succeeded in getting a wax cylinder that was perfectly satisfactory. The most difficult sound to catch and reproduce seemed to be the 'sh' sound, as in the word 'sugar.' I spent eighteen days standing before phonographs containing wax cylinders of various formulas, gazing into them, and only saying 'Sugar!' At last I succeeded in getting a perfect cylinder that would reproduce it properly, but I was so tired of the word that it was a month before I enjoyed anything with sugar in it again!"

"And that reminds me," continued Mr. Edison, in most charming digression, "that people think it strange that I take no interest in my perfected inventions. The incident of 'sugar' will explain why. While engaged in an invention I work at it so hard and constantly that by the time it is perfected I am so tired of it that it is a relief to get away from it. After I put the motion-pictures before the public I fairly hated the sight of them, and felt as though I never wanted to see one again. I wanted to go at something else!"

"Alexander, sighing for more worlds to conquer," thought the visitor.

CYLONITE CYLINDERS

"To return to our kinetephone motions," Mr. Edison resumed, "after the temporary record is made in the soft wax cylinder, it is then transferred to a cylinder made of cylonite. What is cylonite?" He smiled that quizzical smile. "That is a secret of our laboratory. Enough to say that it will make a record clearly, and is practically indestructible. Here is one. Observe this." He took up a cylinder looking much like the ordinary hard rubber cylinder of the phonograph, and dashed it down with all his force to the floor. It was absolutely uninjured.

"These cylonite cylinders," he continued, "are infinitely superior to the rubber ones in every respect.

"In transferring from the wax to the cylonite cylinder," he explained, "two phonographs, one containing the record-bearing wax, the other the blank cylonite cylinder, are set facing each other, about two feet apart. Both are geared to the same shaft, insuring absolute identity in speed. The machines are set going, and the cylonite cylinder receives the record from the wax one. Later it is hardened, thus making it ready for practical use."

"And that's simple too," exclaimed the visitor. "Columbus again."

"One more difficulty I found I had to overcome," said Mr. Edison. "That was to do away with the echo. You see, the wax cylinder had to be made so impressionable that it would record the slightest sound. Now, as the recording phonograph was sometimes quite a distance from the voices or sounds to be recorded, the result was that it recorded the echoes of these sounds against the walls of the studio also! They annoyed me greatly."

"And how did you get around that?" asked the visitor eagerly.

"Simply by using a tent of soft, flexible material. Yes, it was simple, but I was sorely annoyed before I bethought myself of that device."

"Simple, indeed!" inwardly ejaculated the visitor, "but, shades of America's discoverer, who but Edison would have thought of it!"

"Thus, I overcame my difficulties in the perfection of the kinetephone," he said. "The practical operation of the invention is very simple. The perfected phonograph with the necessary record in it is placed behind the motion-picture screen. It is then geared to the motion-picture machine containing the appropriate film, so both picture machine and phonograph will run absolutely synchronously or contemporaneously. That is all."

WILL BE POPULAR

That the kinetephone will become immensely popular Mr. Edison feels assured. "Heretofore grand opera as sung by the renowned singers of the world has been only for the wealthy classes," he said. "The poor man has not two to five dollars to expend on an evening's entertainment, no matter how excellent it may be. Soon for 5 cents he may hear music as well sung, or rather just as it is sung, by the most noted singers.

The motion-picture patrons will see and hear them as though upon the stage, living, breathing personalities."

And here, with his whimsical smile, Mr. Edison dropped into a paraphrase of Anecreon's ode, thus:

"And here is one substantial advantage that the kinetephone will have over the modern stage," he continued. "There will be real houses, real dogs, real trees, real greensward, real everything, in fact, instead of the *papier mache* substitutes of the stage. Scenes can be reproduced from appropriate surroundings, unhampered by the limitations of today's dramas."

Nor is all this a utopian dream of a visionary. These kinetephone productions will be placed before the public in a very short time. Their first appearance will be as a novelty in vaudeville houses, a large promoter in that line having obtained the right for a limited period. Eight motion-picture houses are now being fitted up in New York for their production.

A little later the kinetephone will be placed in all motion-picture theaters. As the ordinary motion-picture machine may be readily fitted at small expense with a kinetephone, plays will soon be as cheap as the ordinary motion-picture plays are now.

The great inventor declares that he will not sell the rights to make kinetephone pictures to other motion-picture concerns, but will retain them solely for his own company. With his announced policy of making only high-grade productions, he thinks their influence will be elevating and that they will generally supplant certain low-priced vaudeville that at present is more or less objectionable.

Millions have been refused by Thomas E. Edison for his new talking pictures and two other late inventions, which bring are a diamond-tipped reproducing needle that will wear forever, and a process for making phonograph records of an unbreakable material called "condensite." These inventions were lately heard officially at a public demonstration of the talking pictures in New York. The Cleveland and Chicago capitalists will endeavor to buy the patents.

Rumor that a wealthy Chicago man and several Cleveland financiers were after the talking-picture rights or an interest in them revealed that an actual offer had been made and refused.

Mr. Brady would not say who his clients were. It was learned, however, that he, in company with at least one of them, recently visited Mr. Edison primarily to investigate the adaptability of the famous Edison storage battery as motive power for railroad locomotives and interurban trolley cars.

An incidental demonstration of the talking pictures by Mr. Edison himself led to the offer for the invention. The matter of the storage battery is still pending.

Mr. Brady, after a hurried trip west, returned to Orange with the certified check, only to have it pleasantly refused. Mr. Edison, it was learned, hoped to control and operate the invention himself, and with this in view is training twelve young men at the factory.

"I not only offered him a million dollars merely as an evidence of good faith of the larger offer to come, but made a proposition for large royalties on every reel," said Mr. Brady. "He doesn't want money."—*Industrial Advocate*.

Electricity and Pure Drinking Water in the Cities

(*Continued from page* 349)

of reverse currents. The electricity, ... through, rather than

GEAR WHEELS AND GEARING SIMPLY EXPLAINED—Part IV

ALFRED W. MARSHALL, M.I.MECH.E., A.M.I.E.E.

A kind of gear which is frequently adopted when the driven wheel is required to give a much lower number of revolutions in a given interval of time than the driver is shown by the sketch, Fig. 40. The arrangement is called worm gear. The driving wheel is a screw *S*, and is called the worm. The driven wheel *W* is provided with teeth, and is called a worm wheel. Imagine the

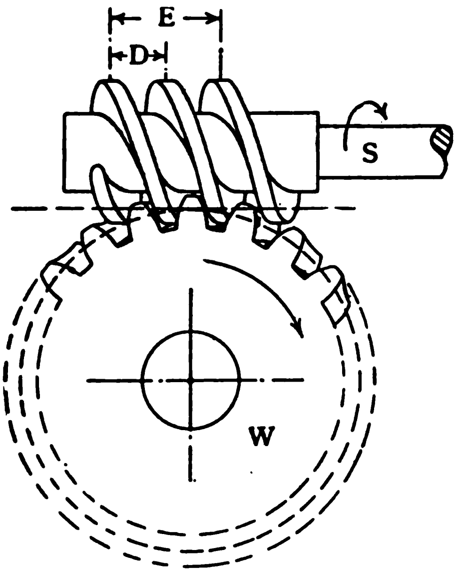


FIG. 40.

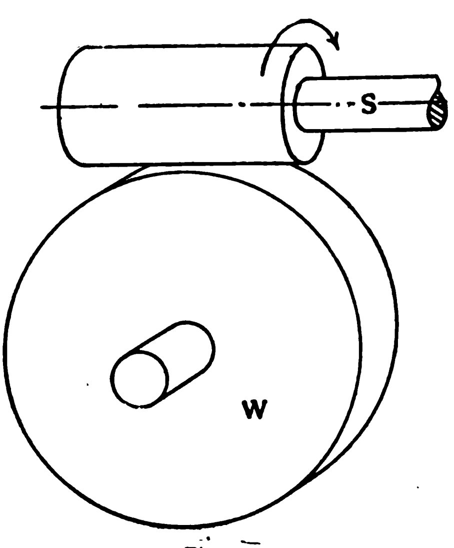


Fig. 41

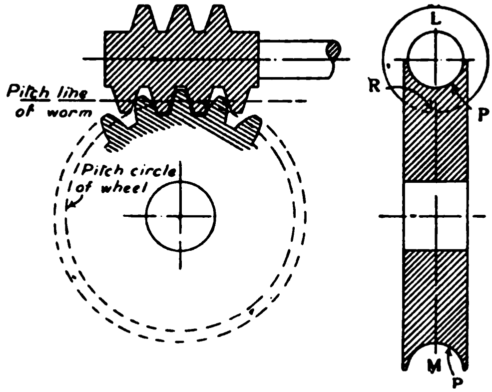


Fig. 42

wheel *W* to be fixed so that it cannot rotate. If the worm *S* is rotated, and can move also in a direction along the line of its axis, it will act as if *W* was a nut through which it was being screwed, because the thread of the worm is engaging with the teeth of the wheel. It will therefore move in a forward or backward direction, depending upon the direction in which it was being rotated. If, on the contrary, the shaft of the worm is held between thrust bearings so that it cannot move in an end direction, and the wheel *W* is free to rotate, it will do so if the worm is rotated. As the worm is unable to screw itself past the wheel, the latter will rotate, due to the sliding action of the worm thread upon the wheel teeth. The rotation of the shaft *S* will be thus transmitted to the shaft upon which *W* is fixed.

This kind of gearing, though equivalent to a pair of spur wheels in its action, differs to some extent. Either wheel of a pair of spur wheels may be made to drive the other, but though the worm can always be made to be the driver, the wheel cannot be made to drive the worm under all circumstances of design. As in the case of spur wheels, the gear is planned by pitch lines and surfaces. There is this difference, however—the pitch surfaces of spur wheels roll together, and, as already explained, one would drive the other by contact friction if the load upon the driven wheel is not in excess of the grip obtained between the surfaces. The pitch surface of the

worm gear, Fig. 40, is represented by the sketch, Fig. 41; obviously, if *S* is rotated, its effort will be expended entirely in a line parallel to the shaft of *W*, and will not produce any rotating effects at all on *W*. The surfaces will merely grind together without producing any turning effort upon *W*. Similarly if *W* is rotated, the effort will be expended entirely in a line with the shaft of *S*, and no rotating effect will be produced. Any rotary effort can therefore only be produced by providing *S* and *W* with teeth which are placed at an angle to the axes of the shafts and can slide against one another. This is effected in practice by means of a screw thread upon *S* and teeth upon *W*, which are placed at an angle to correspond with the inclination of the screw, so that the two will engage in gear. The amount of rotation which will be given to *W* for each complete

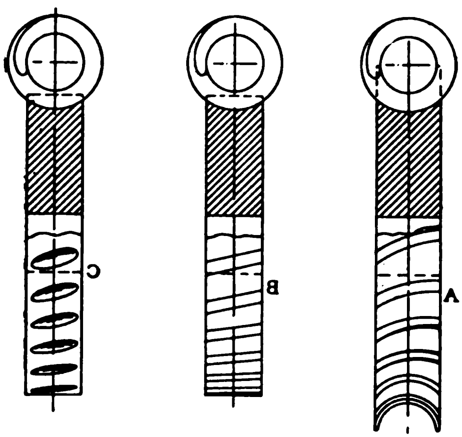


Fig. 43

revolution of *S* will therefore depend upon the pitch of the screw thread. This pitch divided into the circumference of the pitch circle of the worm wheel gives the number of revolutions which the worm will make to produce one complete revolution of the wheel.

pitch of a screw is the distance through which the thread advances whilst making one complete turn round its axis, *S* must make twenty complete revolutions to drive *W* through one complete revolution. If the screw thread is made to have a pitch of 2 in., the wheel *W* would then be made to have ten teeth of 2 in. circular pitch. The screw would now make ten revolutions to drive *W* through one complete revolution. So far, the number of teeth on *W* has been made proportional to the ratio of the gear, that is, we have halved the number of teeth whilst obtaining half the number of revolutions of *S* required to obtain one complete revolution of *W*. But we need not have reduced the number of teeth on *W*. We could have allowed the screw to gear into alternate teeth, half of the number of teeth thus being unused. The arrangement would effect the desired result, as the screw would move the circumference of *W* through twice the distance each revolution which it made, than when its pitch was 1 in. It would thus give one revolution to *W* when its own shaft had made ten instead of twenty turns. But it would not be a good arrangement to permit half of the number of teeth to be idle. The whole twenty teeth can be utilized by providing a second thread upon *S*, interspaced with the first thread, so that it gears with the idle teeth. Each thread will then take a share in driving the wheel, and the pressure and wear will be distributed over double the amount of contact surface. It would be necessary to re-shape the teeth, so they properly gear with the altered curve of the screw due to increasing the pitch. The wheel *W* thus retains its previous number of teeth, namely, twenty, and yet makes one revolution for ten instead of twenty revolutions of the screw. Similarly, the screw may be made to have three or more threads.

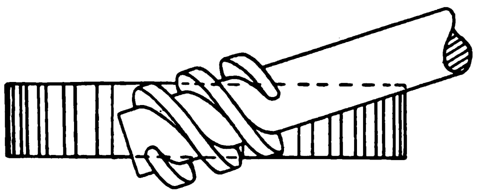


Fig. 44

worm thread in its action with the wheel. Referring to Fig. 40, if the worm has a single thread, its pitch will be the distance D, and this will be equal to the circular pitch of the teeth on W. But if the worm has a double thread its pitch will be the distance E; this will be twice the length of the circular pitch of the teeth on W.

When preparing the worm blank and wheel blank for cutting, allowance must be made for the distance beyond the pitch line by which both the thread of the worm and teeth of the wheel will project. If a section be taken through the center-line of the worm, the teeth of the wheel and thread of the worm can be regarded as a pinion and rack at that line, the screw thread representing the rack, and may be designed upon the method used for determining the shapes of the teeth of a pinion and rack. They may be curved upon the cycloidal or involute principle. If the former method be used, the teeth and screw thread will both have curved sides; if the involute method be adopted, the sides of the screw thread will be straight lines, as explained in an earlier part of these articles. The involute principle is usually adopted, because it is easier to cut the worm thread if it has straight sides. Fig. 42 is a sketch showing such a section of a worm gear through the center line LM.

If the teeth of the wheel accurately fit the spaces between the thread of the worm throughout the entire breadth of the wheel following the true curve of the screw, the shape will alter in section, according as the distance from the center line LM is increased. A section of any tooth taken on any line but LM will show a different shape from that taken on line LM. In addition to this, the circumference of the wheel must be hollowed to fit the worm at the points of the teeth and bottoms of the spaces between the teeth, the curves being arcs of circles of two different radii, as indicated by PR, Fig. 42. On this account shaping and cutting the teeth of a worm wheel correctly is a difficult matter. The method adopted in practice, especially for wheels of small or comparatively small sizes, is to shape them by means of a cutter which is a fac-simile of the screw intended to gear with the wheel. This cutter is called a "hob," and consists of a steel worm of the exact shape of the worm which is to gear with the wheel; it is provided with cutting edges and hardened. The teeth of the wheel are first cut nearly to size by means of an ordinary circular cutter; the hob is then geared with the wheel, and the two are run together until the hob has cut the teeth to the true shape. Obviously, if the hob is a correct representation of the worm it will remove all irregular places from the teeth and leave them a perfect fit to the actual worm. It is sufficient, therefore, to plan the thread and teeth upon a single section LM through the center line of the worm and wheel.

A correctly shaped worm wheel will then have the appearance of A, Fig. 43. On account of the expense of making a hob, worm gears are frequently made to a compromise. The circumference of the wheel is not hollowed at all, but straight, as in the case of an ordinary flat spur wheel. The teeth are cut upon the slant, as indicated by B, Fig. 43, at an angle to correspond to the inclination of the worm thread. Another method is to make the circumference of the

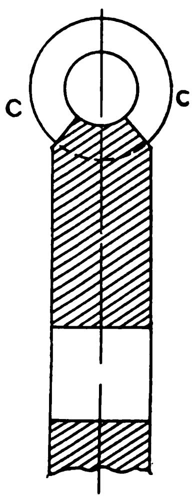


Fig. 45

wheel straight and cut teeth by causing the edge of a circular milling cutter to dip down into it, as indicated by *C*, Fig. 43, technically called "gashing" it. If the axis of the worm need not be at a right angle to that of the wheel, an ordinary flat spur wheel can be used by slanting the worm until its thread meshes with the teeth of the wheel, as indicated by Fig. 44. Any one of these methods, Figs. 43 and 44, may be used successfully, and for transmission of very small amount of power or purposes of mechanical adjustment only the worm can be an ordinary Whitworth or similar screw thread. In practice the edges of the wheel are usually beveled off, as indicated at *C*, Fig. 45, except in the

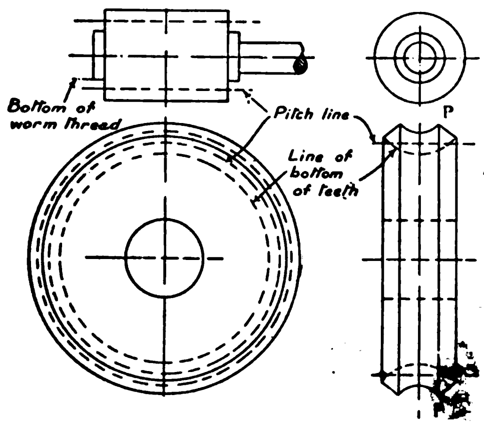


Fig. 46

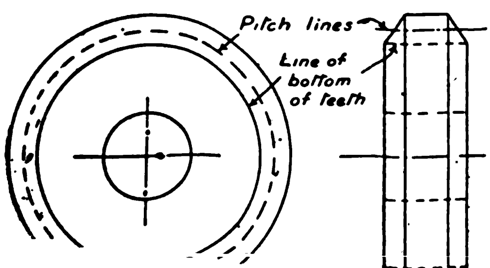
case of wheels like *C*, Fig. 43. This diminishes the inaccurate portion of the teeth and removes the weak corners. A blank worm and wheel ready for cutting a gear such as Fig. 40 would have the appearance indicated by Fig. 46 if the eeth were to be of perfect form and shaped by means of a hob. The dotted lines show the pitch lines and the allowance of metal to give the part of teeth

Fig. 47 shows a blank wheel similar to Fig. 46, but which is to be cut with straight-through teeth, as *B*, Fig. 43. The throat *P* is now made straight, and not curved, as in Fig. 46.

The diameter of the worm has no influence upon the ratio of the gear. As already explained, this is determined by the lead of the worm thread, and the circumference (and therefore the diameter) of the wheel. If the distance between the shaft centers of worm and wheel is fixed, you must select a lead for the worm thread which will give you the ratio desired. The diameter of the worm can be made greater or less, to accommodate the size of wheel found to be suitable in the particular instance. For example, suppose the distance between the centers will admit a wheel having a circumference of 10 in.; the pitch circle for this will have a diameter of 3 3-16 in. If the worm thread is made with a lead of one turn in ½ in. (½ in. pitch), the ratio of the gear will be 1 to 20, because each revolution of the worm will rotate the wheel by ½ in. As there are twenty half inches in the circumference of the wheel, twenty revolutions of the worm will be required to rotate the wheel through a distance of 10 in. If a ratio of 1 to 10 be required, it can be obtained by making the worm thread with a lead of one turn in 1 in. Ten revolutions of the worm will then produce one revolution of the wheel. If a greater ratio than 1 to 20 be required it can be obtained by decreasing the lead of the worm thread. For example, if the lead is one turn in ¼ in., the ratio of the above gear will be 1 to 40, as there are forty quarter inches in a circumference of 10 in.; therefore, forty revolutions of the worm will be required to produce one revolution of the wheel, and so on. If the worm thread is made to have a lead of 1-10 in., the ratio of the gear ... The lead may be one ... to 5.

be advisable to cut four or five threads. The wheel would then have twenty or twenty-five teeth respectively. Should the circumference of the wheel pitch circle, as first determined, prove to be inconvenient to the number of teeth, it may be increased or decreased to a limited extent and the diameter of the worm altered to accommodate the difference. When the centers are not fixed, the wheel size is limited only by convenience of construction. It is advisable to have at least thirty teeth in the wheel, if convenient. When a smaller number must be used, the top edges of the worm thread do not properly clear the wheel teeth. This interference can be avoided by a slight rounding off towards the tops of the thread or by increasing the diameter of the wheel so that the teeth project almost entirely outside the pitch circle. Messrs. Brown and Sharpe, in their treatise on gearing, give the following rule for this increase of diameter. The pitch diameters to be multiplied by .937; add to the product four times the addendum, that is, the part which in the ordinary way would be outside the pitch circle. The sum gives the diameter of the blank at the throat P, Fig. 46. The whole diameter of the wheel is obtained by making a drawing to this rule and measuring off the dimension. They say, however, that it is not practical to finish wheels sized by this rule with a hob when they have twelve to eighteen teeth unless the wheel is driven by separate mechanism; the hob must not be relied upon to drive the wheel.

Professor Unwin gives the following proportions for worm gearing, P being the circumferential pitch of the wheel teeth. Thickness of tooth on pitch line, .48 p; height outside pitch line, .3 p;



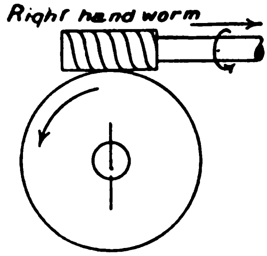


Fig. 48

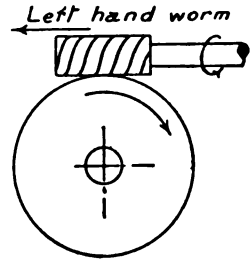


Fig. 49

depth below pitch line, .4 p; length of worm, 3 to 6 p (usually 4 p); width of wheel face, 1.5 to 2.5 p. The worm is frequently made of some different metal from that used for the wheel. For example, a steel worm and gun-metal wheel, a hardened steel worm and a phosphor-bronze wheel, give good results, a wrought iron or steel worm and cast-iron wheel are also used; a cast-iron worm can be used with a cast-iron wheel. When the gear is used for continual running and transmitting power for driving purposes, the shape and materials used are of much greater importance than when the gear serves for adjustment purposes and occasional use. A hardened steel worm and phosphor-bronze wheel is a very good combination for transmitting power, but efficient lubrication of the surfaces in contact is the most important factor. The gear should run in an oil bath, if possible. Worm gear was at one time regarded as a very inefficient means of transmitting power, but during recent years it has come into extensive use for this purpose, and, if well designed and run in oil, is found to have high efficiency. The loss of power due to friction between the worm thread and wheel teeth decreases with increase of the inclination of the thread, that is,

multiple threads thus give a higher efficiency than single-threaded worms, and a small diameter worm gives a higher efficiency than one of corresponding lead, but larger diameter. In addition to the friction at the worm thread, there is friction set up by the end thread of the worm shaft. This is also of importance, and some form of thrust bearing is required if high efficiency is to be maintained; a ball thrust bearing is very good. As previously explained, the worm must be prevented from moving end-wise, if it is to exert pressure upon the wheel teeth and rotate the wheel; therefore, the wheel teeth will press against the worm thread with a force proportional to the load which the wheel has to drive. The teeth therefore thrust the worm shaft against the bearing in which it runs. The direction in which the wheel rotates for a given direction of rotation of the worm depends upon whether the worm thread is

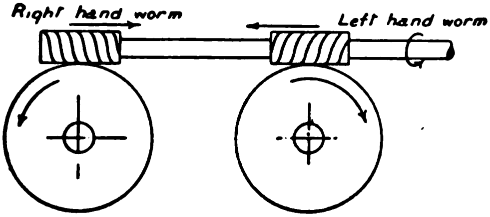


Fig. 50

right- or left-hand. It is possible on this account to combine two worm gears so that end thrusts of the worms oppose each other, and no thrust comes upon the bearings. Fig. 48 is a diagram of a worm and wheel, in which the thread is right-hand, and Fig. 49 is a similar design, in which the thread is left-hand. The arrows indicate the direction of rotation and thrust. The worm shaft rotates in the same direction in each instance, but the wheels rotate in opposite directions, and the direction of thrust exerted upon the thread of the worm, and worms. The driving force of the wheels can be combined and transmitted to a single shaft by means of spur wheels.

A distinctive feature of worm gearing is that it is not always reciprocal—that is, the worm will always drive the wheel, but the wheel may not drive the worm. If the lead of the worm is small, and therefore its angle small, the friction between the surfaces in contact will be so great that the worm cannot be rotated by the wheel. The critical lead of thread at which the wheel can drive the worm will depend upon the friction between the surfaces in any particular instance. Generally speaking, single-thread worms cannot be driven by the wheel, but if the lead required is sufficiently great to necessitate a multiple thread, the wheel may drive the worm; the greater the lead, the more likely is the gear to be reciprocal.—*The Model Engineer and Electrician.*

All About Permanent Magnets

The British Journal of the Institution of Electrical Engineers contains the lecture on permanent magnets which Professor Silvanus P. Thompson delivered at the meeting of the institution at Glasgow last year. It occupies more than sixty pages, gives a complete account of present-day knowledge on the subject and points out directions in which further research is necessary. The author shows that the most powerful and permanent magnets are made of steels with about 6 per cent. of tungsten and 0.5 per cent. of carbon, and have the ratio of length to breadth large. After forging at as low a temperature as possible the magnets should be heated to 900 degree C, cooled to 750 degrees C, kept at that for a time, and then cooled off. Hardening is a repetition of this process down to 700 degrees C, at which temperature the magnets are to be plunged into brine at 20 degrees C. Maturing is done by boiling the magnets for ten or twelve

BOOK RACKS AND DESK TOPS

Variety of Designs—Single and Combination Affairs—Details of Construction—Best Woods for the Purpose

GEORGE E. WALSH

Book racks, desk tops and ornamental tops for old book-cases make suitable presents for friends as well as desirable articles for one's own use. There is considerable variety in such useful articles, and one may use ingenuity in designing them to fit any special need. Sometimes it is an old desk with merely a flat top which could be greatly improved by designing an ornamental book rack with pigeon-holes on the side for papers, or it may be an entirely new top is needed. Such a new top was designed and made for an old desk after the pattern in Fig. 1. The legs and sides of the desk were in good condition, but the top had been split and badly used, and it never was very pretty or ornamental.

The dimensions of the top of the desk were taken and the design drawn to fit snugly on it. When finished sufficient room was left between the side book-racks for writing purposes and two small desk drawers were provided for pens and papers. The lid of the old desk lifted up, but this was screwed

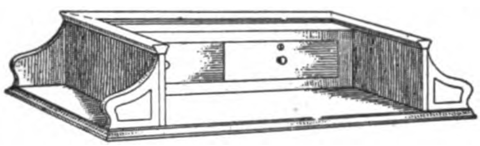


Fig. 1—One Style of Desk Top

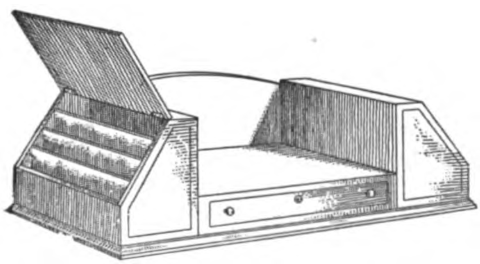


Fig. 2—A Book Rack and Letter File

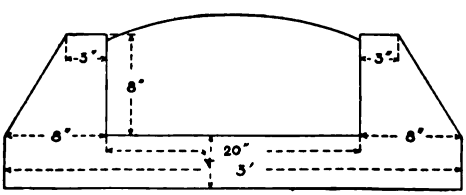


Fig. 3—Dimension Diagram for Book Rack and Letter File

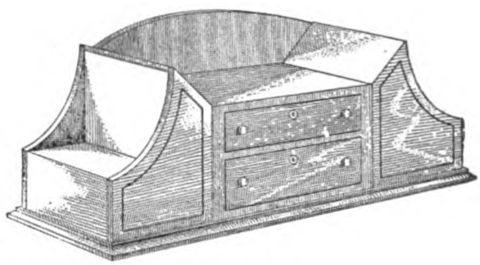


Fig. 4—Another Style of Combination Book Rack and Letter File

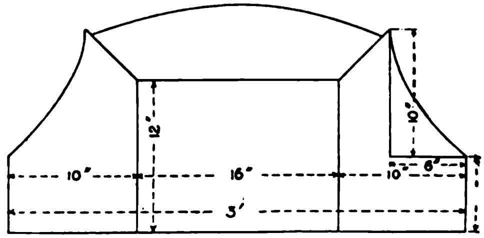


Fig. 5—Dimension Diagram for Previous Figure

down, and a drawer fitted in front to take the place of the old space. No space was lost by this operation, and much was gained in the way of an ornamental article of furniture. The book spaces on either side of the desk top were found to be of invaluable aid, for in them were kept all books needed for ready reference.

Combination book racks, drawers and letter files are among the most useful of ornaments for topping off book-cases, desks and mantel-pieces or side tables. If artistic in design and execution they will finish off many old pieces of furniture better than can be accomplished in any other way. The two designs shown in Figs. 2 and 4 will clearly indicate their purpose. In one we have either side of the article finished off with small letter file arrangements, with lids to cover them and a center space for books, magazines or other articles. The shallow drawer furnishes room for small articles such as paper, pens, letters and envelopes. Placed on top of an old book-case, it occupies a conspicuous place and adds greatly to the ornament of the room. In Fig. 4 rather more space is given to books, which are placed on either side

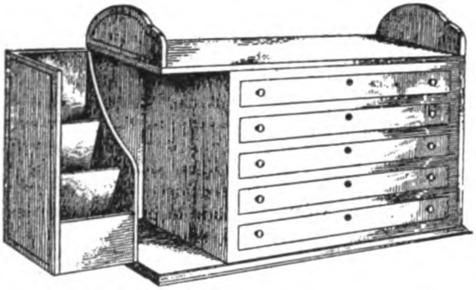


Fig. 6—A Combination of Drawers and a Book Case

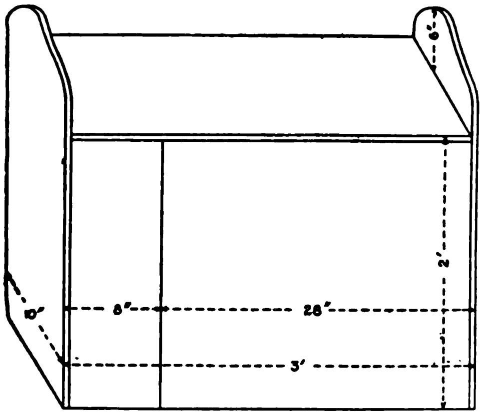


Fig. 7—Dimension Diagram for Article Shown in Previous Figure

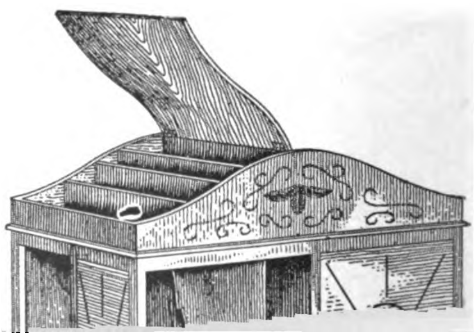
and in the center, but two drawers are provided for small articles.

In Fig. 6 an attempt is made to build up a series of shallow drawers, with a side space for bills and letters that opens and closes on hinges, and the top space finished off as an ordinary book rack. Such a generally useful article may be made in almost any suitable height desired for special purposes. If to fit on the top of a desk, table, book-case or mantel-piece it should not exceed 2 ft. from the base to the book rest on top. In that case the number of drawers should be cut down to about three. A tier of five is more suitable for a case 3 or 4 ft. high and designed to rest on some low article. This combination

In Fig. 8 we have another combination book-rack and a letter file. The top of the case is devoted entirely to spaces for letters and papers, divided off in compartments as one desires. Some of these spaces are quite shallow and others quite deep. The doors swing on hinges from the top center and fall down snugly on the sides to finish off the top. If one found it difficult to make doors with curves in them, the top could be made flat or sloping with a peak at the top. That is merely a matter of individual taste and capacity. The designs are intended more as a guide than to follow absolutely in every particular. The lower part of the case is made entirely for books which are placed in the four compartments.

The design can be made on the plan of the ordinary revolving book-case, or with the compartments simply divided by upright posts at the corners. In the illustration the design has every alternate space panelled, which can be done in any way desirable. A design may be burnt on the panel or it can be finished off with strips of wood, following some simple drawing.

The wood for making any of these ornamental tops should preferably be birch or maple. There is no better wood for the work than birch. It should be obtained from the mill in two thicknesses—one-quarter of an inch and three-quarters.



The thin boards are used for making the partitions between letter compartments, filing arrangements, pigeon-holes and shallow drawers. The thick boards are for the rest of the work. The thin pieces of wood finished off in the natural colors of the wood will contrast beautifully with a mahogany stain given to the outside part.

If the articles are to be decorated by burning, the best wood to select is good basswood. This is nearly grainless and does not split easily for a soft wood, and it takes pyrographic work better than almost any other. Most soft woods when cut as thin as a quarter of an inch are too fragile to be of much use and a very slight pressure will split them. But good basswood is not so easily ruined. All inside partitions should be glued in position and not nailed. If one is deft enough with tools to fit them together with groove and tongue all the better, but it is easier to glue the small pieces in. Only the best furniture glue should be used for this purpose, and that means it must be prepared for the purpose. Self-prepared glues are hardly strong enough. Get a pot of glue and keep it hot while working, and when a piece is glued in position it must be kept there under pressure for at least 24 hours.

All the designs, with the exception of the book-case with a curved top, are made in simple straight lines, and any one who can saw out and fit a square box together accurately should be able to make any or all of these useful ornaments. A scroll saw may be necessary for cutting out some of the pieces to advantage, but they can all be made without it. Besides the lumber mentioned above a few feet of molding should be purchased at the mill. This is to finish off the base of each article. The sides and upper part can be decorated with a few strips of beaded mill-work, which can be bought at a mill or carpenter's shop

After the different parts have been cut out and put together, the edges should all be sandpapered down to a very smooth finish. Then the surface should be rubbed with some good filler so that all the open grain and pores can absorb it.

When the filler has dried properly the stain should be applied, rubbing it in and wiping it off carefully. This in turn must dry before oil or varnish is applied.—*The Building Age.*

New Southern Pacific Ferryboats with Double Power Plants

W. ZACHERT

All of the public service corporations in and around San Francisco are making great preparations for the enormous increase in travel and the large activity in trade that is expected when the Panama Pacific Exposition is opened in 1915.

In line with this, the Southern Pacific Company has just placed an order with the New Jersey Shipbuilding Works for a large steel ferryboat to run between San Francisco and the Oakland Mole. It is stated that the hull alone will cost $98,000.

The name of this new vessel will be the *Santa Clara*, and it will be a duplicate of the *Alameda*, which is now under construction at the West Oakland Shipyards.

Both of the above ferryboats will be built of steel throughout, and will be provided with longitudinal water-tight bulkheads. They will be of the side-wheel type, and each wheel will be independently operated by its own engine of 2,800 h.p. These boats will be twice as powerful as any of those now in the service of the Southern Pacific Company on San Francisco Bay. Each vessel will have two smokestacks and Babcock & Wilcox water-tube boilers; in fact, on each side of the boat there will be a complete and independent power plant. The cabins will be of mahogany finish. Each boat is to have seating capacity for 2,600 passengers; this is 900 more than that of the Ferryboat *Berkeley*, which is at present the largest Southern Pacific vessel crossing the Bay.

The time required for making each trip between San Francisco and Oakland is 20 minutes, but when these swift new steamers are placed in commission, the time will be cut down to 12 minutes; thus travel across the Bay will become quicker and more frequent.

Another contract will soon be let for a third boat, which will be called the *San Mateo*. It will be exactly similar in every particular to the two mentioned above. The *Alameda* will be completed and placed on the run in about six months. All three of these ferryboats will be in full operation by January, 1915, in time to handle the immense traffic in connection with the opening of the Exposition.

A SIMPLIFIED POTENTIOMETER

H. S. MANISTY

As probably most of our readers already know, with a potentiometer and its accessories many things can be done. For example:

Small and also very large voltages can be measured, though in the present case the range will only be from 0 to about 30 volts, reading to about .1 per cent. Small resistances, such as armature coils and also large ones, can also be accurately measured. An ammeter is necessary for this, as a piece of extra apparatus. Small and large currents also come within its range with great accuracy. It is specially useful for graduating volt and ammeters.

I will now try to make clear the principle of this apparatus. It is based on Ohm's law, which shows that the fall in potential down a uniform wire carrying a current varies directly as the length of the wire, and also that when two equal and opposite potentials are present in a circuit no current flows in that circuit.

The instrument consists of five parallel wires of No. 30 S.W.G. manganin, and 1 meter long, connected at their ends to heavy brass bars, slit, as seen in the plan, Fig. 1. These bars are considered to have no resistance compared to the wires, and the arrangement is virtually one wire 5 meters long. A constant current is passed through this (about 1/8 amp.) from two accumulator cells. This current is regulated (by cutting out more or less of the last two wires with a piece of thick flexible wire) till the drop down 1 meter length is exactly 1 volt, then the drop down the 3 meters is 3 volts. The so-called setting is done by comparison with a standard cell.

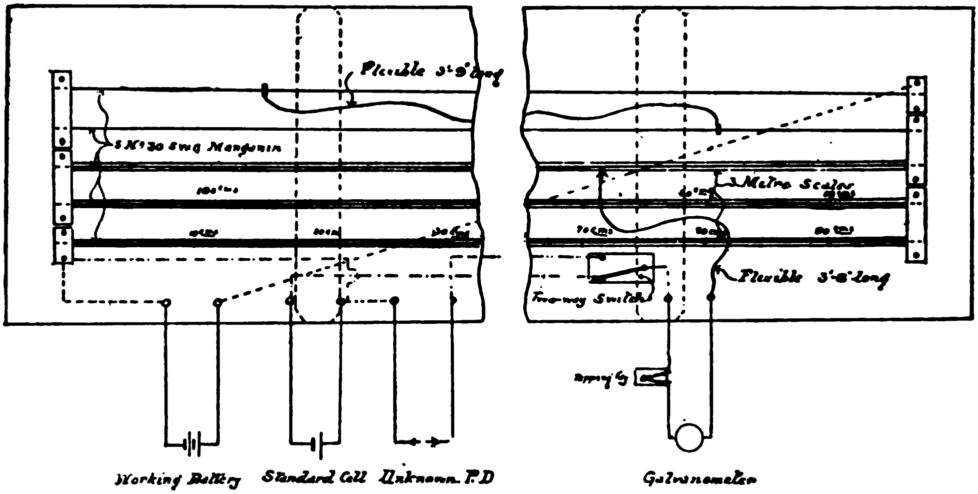


Fig. 1. Plan of Potentiometer, showing Connections (Scale 2¼ in. to 1 ft.).

The first thing to describe will be the potentiometer proper. The base is a board 3 ft. 9 in. long and 10 in. broad, cut from well-dried ½ in. pine. It has three stiffening pieces at the back, 1½ x ½ in. This must be of dry wood, planed smooth, and then it is given a couple of coats of shellac varnish and allowed to dry while the other parts are being got ready. The wires, as mentioned, are No. 30 S.W.G. manganin; five pieces 41 in. long will be wanted. Cut off two pieces of strip brass ½ x 3-32 in., or a little thicker; draw-file this all over. Drill six countersunk holes for ½ in. brass screws in the position shown on plan. On the underside scratch five shallow slots to fit the wires; these are to be spaced as drawn. Fix the two strips down temporarily on a board, their inside edges exactly 1 meter apart (1 meter = 39.3708 in., or about 3 ft. 3⅜ in.). Solder the ends of the wires carefully to the brass strips for the full length of the brass, and then

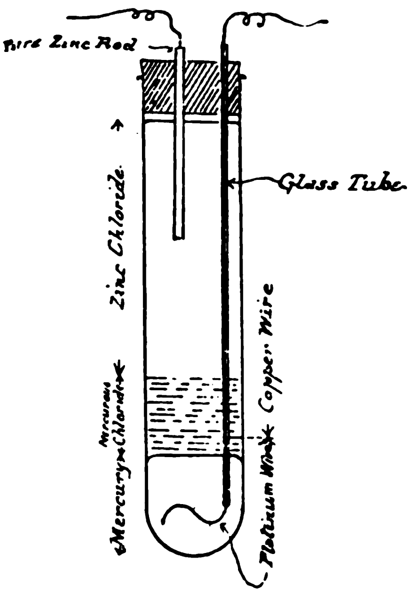


Fig. 2. A Calomel Cell

carefully stretch and solder the other five ends, so that each wire has 1 meter free length and all are stretched alike. Trim off the odd ends and unscrew from the board, and screw down right side up to the final base, still keeping the brass exactly 1 meter apart. Three paper scales 1 meter long and divided into centimeters are to be fixed under the first three wires; it would be safer to fix these scales before the brass, as they should have a coat of varnish, and the wires must be left clean. Six terminals are to be fixed, spaced evenly in pairs along one side. The connections can be easily followed from the plan.

A standard cell is the next thing to make. For all work not requiring very great accuracy a calomel cell is the best, as its variation with temperature is very slight; but for more accurate work a Clark Standard should be used, made up to Board of Trade specification, as described in S. P. Thompson's "Electricity and Magnetism." In this case the temperature must be taken into account. I will here describe the calomel cell. All chemicals must be bought as "pure."

The cell (Fig. 2) is set up in a wide test tube about 1 in. diameter and 4½ to 5 in. long. In the bottom of the test tube is poured about 1 in. of mercury, and dipping into this is a fine platinum wire, enclosed till it reaches the mercury in a fine glass tube. The tube is drawn out to a blunt point and the wire passed through. The tube is then heated till the glass flows round the wire and seals it in. A short length of platinum wire, say 2 in., need only be used, and a thicker copper wire soldered to the end, which also forms one terminal. Above the mercury is ¾ in. to 1 in. of mercurous chloride.

On top of this again is poured a saturated solution of zinc chloride. A cork is fitted, and passing through this is a small rod of pure zinc; this forms the other terminal. The cork is sealed with paraffin wax, and the whole arranged in some form of stand to keep it upright. This cell gives a voltage of very nearly 1 volt; to be exactly 1 volt, the specific gravity of the zinc chloride must be 1.38. Two or three cells should be made up, so that they can be checked against each other.

A galvanometer is essential, but I will not describe one here, as nearly every amateur has one, and if not, very good descriptions will be found in back numbers. The galvanometer must be sensitive and also have a high resistance; if not, some high resistance must be

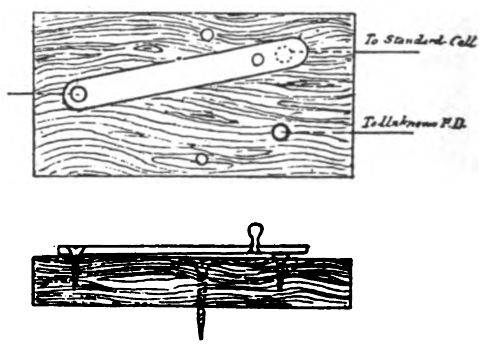


Fig. 3.—Two-way Switch.

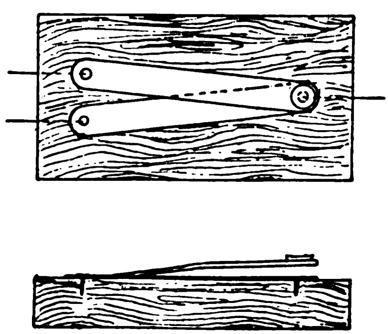


Fig. 4.—Tapping Key.

inserted in its circuit. The accuracy of the results depend largely on the sensitiveness of the galvanometer and the correctness of the standard cell. There is one other small thing to be made before any readings can be taken, that is, a flexible connection to cut-out part of the last two wires.

Cut out from springy copper or brass four pieces, 1 x ¼ x 1-32 in.; file one edge of each to a slight bevel. Turn bevels inwards and solder the opposite edge, and also solder one end of a piece of flexible to each pair, so as to form a clip. Now each end can nip the fine wire at any part, and so vary the resistance. This will give a variation of about 12 ohms.

Two switches will be needed—one a two-way switch to switch from the standard cell to the unknown *PD*, and a small tapping key to connect up the galvanometer. The two-way switch (Fig. 3) consists of a base of well-dried and varnished wood, 2½ in. long by 1¼ in. wide, of about ⅜ in. or ½ in. wood. A strip of springy brass 2 in. long and of a section ¼ x 1-16 in. This must have a hole drilled at one end and a small knob at the other, so that one end can be screwed down and still free to move sideways. Two brass screws are screwed in, as shown, and their heads left about 1-16 in. above the level of the base. To these the wires from "Standard Cell" and "Unknown Potential Difference" are fixed on the under side, and the galvanometer wire to the fixed end of the brass strip. The general idea will be seen from the drawing. The strip must have a downward set, so as to make good contact. The tapping key (Fig. 4) is made by fixing two pieces of brass strips (2 x ¼ x 1-32 in.) to a small base (2¼ x 1¼ in.), so that when the top one is pressed down it makes contact on the one beneath.

time it was re-charged. Connect up the battery and put the two-way switch to standard cell. Take the wire from the galvanometer marked "flexible," and touch the manganin wire at one meter; with the other hand depress the galvanometer tapping key, and if there is any deflection alter the double-ended flexible connection till there is no deflection. Be careful that the standard cell and battery Potential Difference oppose each other, or they cannot be balanced. Then the instrument is said to be "set," because the drop down 1 meter=1 volt; therefore, the drop down the 3 meters = 3 volts. Of course, if a Clark cell is being used, the manganin wire must be touched at 1.434, the voltage of a Clark at 15 degree C. Now put over the two-way switch to unknown Potential Difference, and find the point on the manganin wire, where, when it is touched with the galvanometer flexible, there is no deflection on depressing the tapping key. This shows that the drop Potential Difference and the unknown Potential Difference are balanced, so read the distance, say 1.421 meters, and this corresponds to 1.421 volts, the Potential Difference of the cell. Again switch back to standard Potential Difference, and check the setting of the instrument. This, of course, should not have altered; but if it has, the trial must be repeated. For higher Potential Differences up to, say, 30 volts, a voltbox must be used. This consists of two coils of high resistance, and the smaller coil has a resistance of one-tenth the total, so that the Potential Difference across the smaller is one-tenth the total Potential Difference.

Make a bobbin 4 in. long between the cheeks, 2 in. diameter, and ¾ in. core, of hardwood (see Fig. 5), and fix between the cheeks and a flange, so as to divide the two parts in the ratio of 10 to 1. Boil the whole in paraffin wax, and wind

the chief thing is to have one nine times as great as the other. For the final adjustment of length, apply a Potential Difference of from 2½ to 3 volts over the two, and measure on the potentiometer the Potential Difference across the whole and also across the smaller one. Then the first must equal ten times the second. To use this the unknown Potential Difference is applied across the two coils in series and the Potential Difference across the smaller measured; then total = 10 times this amount. It would make a better job, but more expensive, if the coils were wound with cotton-covered resistance wire, such as iron or manganin of about No. 36 gauge.

The next step will be the measurement of currents, and for this some extra resistances must be made. A standard ohm coil must be bought or made to start with. There is no trouble in the making, provided there is something to compare it with, as it must be accurate. The checking can be done with the potentiometer if the reader has a reliable ammeter reading to about 2 amps. Pass a current of about 2 amps. through the ammeter and coil, and simultaneously read the potential drop across the coil and the ammeter; then the resistance = $\frac{v}{c}$. This must be adjusted to 1 ohm. On the whole it would be better, if possible, to buy a standard coil, or at least get the loan of one for comparison.

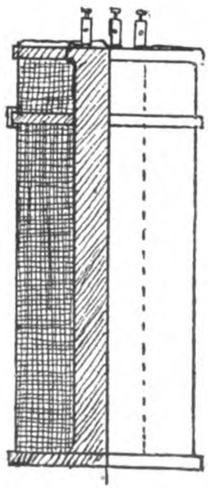


Fig. 5. A Bobbin

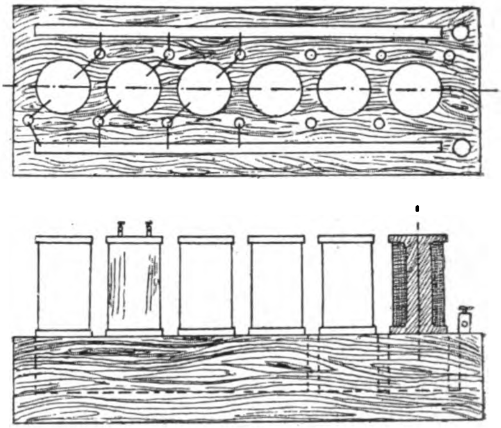


FIG. 6.—RESISTANCE COILS AND STAND.
(*One-third full size.*)

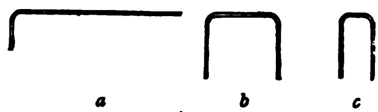


FIG. 7.—CONNECTORS. (*One-third full size.*)

The reader will now need six such coils, made of iron or, far better, of manganin of No. 20 S.W.G. These will enable him to read currents up to 15 amperes. If he requires a larger range, more resistances will be needed. For small currents a resistance-box will do away with all this trouble. For a 1-ohm coil 10 ft. of manganin will be needed—No. 20 S.W.G. cotton-covered. Turn up six bobbins 1½ in. long between cheeks, and the core ½ in. diameter, and cheeks 1 in. diameter, and boil in paraffin wax. Double the wire, and start winding by putting the doubled end through a hole in one cheek; wind on the whole length double, and fix the two ends to two terminals. Now bare a short length of the doubled end, and twist this up till the resistance is exactly 1 by comparison with the standard; solder up this end and tuck it away. Definite lengths cannot be given, as manganin varies in composition and resistance; but the resistance of a length, say 10 ft., can be measured, as will be described, and this will give a good base to calculate from. To each terminal of each coil must be soldered a stout piece of copper wire (No. 12 or 14) bent into an *L*, so that each coil can be connected with a mercury cup.

A stand must be made for these coils,

so that they can be connected in series or parallel, or any other combination, at will, and have a negligible resistance at the contacts. Cut out from a board 1½ in. thick a piece 8 x 3 in., and drill in this twelve clean holes ¼ in. diameter and 1 in. deep; the positions are marked on the drawing (Fig. 6). Cut also a slot 6½ x ¼ x 1 in., as shown. Then boil the whole in paraffin wax. Cut from No. 14 copper wire six pieces as *a* in the drawing, six as *b*, and six as *c*, Fig. 7. With these any combination of the six coils can be made. For example—for a resistance of ⅓ ohm to carry a current of 9 amperes, connect up as is done in the drawing of stand for resistance.

Now the measurement of any current from 0 to 15 can be made. Suppose the reader wants to graduate or check an ammeter, divided into tenths, from 0 to 5. Connect up all the resistance coils in series, and connect the set and the ammeter in series, and pass a current through the whole of about 1-10th amp.; connect the resistance coils by fine wires to the unknown Potential Difference, and read the Potential Difference, then the actual current flowing = $\frac{v}{r} = \frac{v}{6}$. Gradually increase the current till about .4 is reached, taking reading at intervals of both unknown Potential Difference and ammeter scale. At .4 cut out one coil of resistance then current = $\frac{v}{5}$. Keep on in this way, altering the coils so as to keep the Potential Difference reading about 2 volts to 2¼ volts, and never having more than 2½ amps. to any one resistance coil. For example—at 5 amps. two coils must be in parallel. From this, I think, the reader will follow the method of manipulating the resistance coils.

Measurements of resistances can be done in two ways—by direct comparison, or by absolute measurement; this second ...d necessitates the use of an accurate an ammeter is series with the coil, and pass 5 amps. or 10 amps.—if the armature will stand it—through the two. Measure with the potentiometer the Potential Difference across the armature, and read the current passing; then the resistance $= \frac{v}{c}$, if the Potential Difference = .794 and the current = 9.6, resistance $= \frac{.794}{9.6} = .083$.

To measure the resistance by comparison. Connect five resistance coils in parallel; this gives .2 watt to pass about the same current as before through both, but there is no need to know the actual current. Measure first the Potential Difference across the known resistances, and then across the unknown; if the Potential Difference across known resistance = 2.014 volts, and that across unknown = .836 volt, then resistance $= \frac{.836 \times .2}{2.014} = .083$. I think this will show the great usefulness of this simple apparatus, and the reader will very soon find how very accurate it is. What always strikes me is the very large range and at the same time great accuracy over that range.—*The Model Engineer and Electrician.*

Hot Galvanizing Again

A new hot galvanizing process has recently been patented by Professor Charles F. Burgess differing from other previous processes in that it covers the use of an alloy of zinc and iron for coating iron or steel. The alloy is composed of about 92 per cent. of zinc and 8 per cent. of iron and is prepared in a powdered or granulated form. The alloy is applied to the iron and steel in a similar manner to the well-known process of sherardizing.

Arthur D. Little, Inc., of Boston, who touch upon this matter in their report as official chemists to the American Institute of Metals, say that it

DANGERS OF THE SEA

LIEUT. ALEC MC NAB

It seems strange that in this wondrous age of shipbuilding many methods are employed for the safety and guidance of a ship that were in vogue hundreds of years ago. The steady advance in shipbuilding and engineering has produced remarkable changes and luxuries in ocean travel, combined with great protection to the traveling public, still many additional changes must be made to approach anything like absolute safety. Too much time and money are spent on interior decorations and fittings, and too little on appliances which mean much for the safety of the vessel.

Shortly after the recent *Titanic* disaster the United States House of Representatives, and the British Parliament sent up a shout and demanded boats for all, but it is a sad but true fact, that, although boats for all have been supplied on many of our ocean liners, the means for lowering boats for all has been sadly neglected. A landsman, to look at the boat deck of one of the ocean liners today, would feel that the steamship companies have done all in their power to assure the safety of the traveling public by the three tiers of boats which extend forward and aft on the port and starboard sides of the boat deck—but what has been the outcome? Previous to the *Titanic* disaster the boats were placed in such a position that should disaster befall the vessel, and it was necessary to lower the boats, the sailors could, with ease, get at the falls and guys and swing out the davits for lowering away. After the *Titanic* disaster, as I have stated, the cry went up for boats for all—but what have they done? They have congested the original boats so much with the placing of other boats on the boat deck, with life rafts under the original boats, that it is impossible for the sailors to get at the boats they formerly could. Furthermore, lowering purposes under present conditions, and, although there are boats for all, the danger is not lessened.

Furthermore, where are the sailors to man the boats? It was bad enough to man the scant number of boats on the ill-fated *Titanic*, to say nothing of the far greater number of boats placed on ocean liners since that disaster. Stewards, cooks, and firemen cannot handle an oar the same as a sailor can; therefore, if any sea is running, and the boats cannot be handled properly, they will "broach to" in the sea and most assuredly capsize. Personally, I think that the oars for the manipulation and handling of the life boats are way behind the great advance in shipbuilding; as far behind, in fact, as the ancient galley was of the present-day ocean liner. In my opinion, the time is not far off when the oar-propelled life-boat will be a thing of the past and will be superseded by the installation of the internal combustion engine.

It may seem strange for me to state that many of our present-day so-called "sailors" are unable proficiently to handle a boat's oar. The sailors of today are not like the good old "shell-back" of fifty years ago. Because of the great strides made in shipbuilding, ships today can be likened unto a great machine. The sailors are more mechanical than otherwise. The days of splicing ropes, bending sails, holy-stoning the wooden decks and keeping the ship in trim are past. Today, owing to the many mechanical appliances on board ship, the sailor's training is not to be compared to that which he used to receive. The old sailors are dying out, and while occasionally we come across them on board ship, their number is becoming smaller and smaller. I believe that the time will come when a sailor will practically be an engineer, owing to the many mechanical appliances

or battleship when approaching shoal water. The quartermaster is instructed to cast the lead. This crude way of informing the captain of his approach to shoal water is not in keeping with the general makeup of the up-to-date equipment on board ship. The lead consists of a weight fastened to a heaving line, with pieces of bunting reeved through the line at each and every fathom—similar to a flexible scale. Very few sailors are proficient in the casting of the lead, and it usually is the quartermaster's duty to do this. As the vessel is approaching shoal water, under reduced speed, the quartermaster stands on a grating which overhangs the side of the vessel, and casts this lead from time to time—informing the captain of the depth of water during the progress of the vessel. Now, on our modern battleship, trans-Atlantic liners, and other vessels, this would appear, even to the landsman, to be a very crude method of determining a ship's approach to coast—especially in a dense fog. Captain Noah, when he sailed the Ark, could have tied a brick to a piece of grass rope and obtained exactly the same results as with the method employed today.

Another feature which also goes back to the time of Captain Noah is that, until of late, the only way in which the captain or officer could obtain the absolute draft of the ship was by going to the forward end of the vessel to see how far the water came up to his mark at that point, then go aft to the stern of the ship and see how far the water came up to his marks at that point also. Now, this was the only method by which Noah could tell how far his Ark was submerged.

In loading a vessel today the cargo is handled by machinery which places the cargo on board at such a rate that it is utterly impossible under the existing circumstances for a shipmaster or officer to have accurate knowledge of this most important matter—actual draft of his vessel. Furthermore, even under the best of conditions, the method at present employed is crude, as the agitation at the surface of the water prevents an accurate reading's being obtained in this manner. Should disaster befall the ship, the captain must necessarily command one or compartments and ascertain the amount of water the vessel is making. This information relative to the various internal compartments of the ship keeps him advised of the rate at which his vessel is being submerged. Now, it would appear, even to a landsman, that an accurate instrument placed in front of the captain to show him the actual draft of the vessel at all points, as well as informing him of the rate of submersion, should disaster occur, would be of invaluable assistance to him—as he could see at a glance the rate at which his vessel was being submerged because of damage incurred in collision or accident of any sort, and suppose he was making two feet or more of water per hour, he could then figure his time to the nearest point of land—knowing his running distances—and reach land before the vessel was in such precarious shape as to demand abandonment. Many ships have been abandoned at sea and later picked up. Why? Because the information given to the captain and other officers was false and terrifying. Many ships, again, have been abandoned when the rate of submersion did not warrant abandonment.

Another crude method in vogue prior to the *Titanic* disaster was that of determining the proximity of ice at sea. During the vessel's progress a sailor was commanded by the officer to take sea temperature. The method in which this was done was as follows: The sailor would pick up a leather temperature bucket, with a piece of line attached, dip it overboard, get it full of surface water and insert a thermometer (similar to the ordinary household thermometer) in the water contained in the bucket. He would hold the thermometer there for about two minutes, take it out, and shout the temperature to the officer on the bridge: this temperature being entered in the log book as the sea temperature taken at that time. This is repeated once or twice every four hours.

The temperature of the surface water is not the temperature of the sea, as water on the surface will show a temperature between the atmospheric temperature and the temperature of the sea itself. Owing to the difference in specific gravity,

surrounding atmosphere—floats like a blanket over the surface of the ocean. During the time that ice drifts down from the Arctic into the path of trans-Atlantic liners, the atmosphere is of a far higher temperature. This temperature causes the icebergs to break away from the glaciers and drift down towards the path of the ocean steamships. The iceberg, during its southerly progress, creates at a considerable distance below the surface an enormous body of cold water which drifts with the iceberg. The warmer water is on the surface and stays there, owing to the difference in specific gravity. The temperature of this surface water is what is taken on board ship, and, instead of being a help, is very misleading. Still, for years they continued in this way until the loss of the *Titanic*, which, I may state, prompted me to think about the Frigidometer.

Regarding sea temperatures, I can plainly show you how crude and misleading the present method of taking sea temperatures is. In the first instance, the bucket which is dropped overboard is of the temperature of the atmosphere—owing to its exposure on deck. The water which is picked up in this bucket absorbs heat from the bucket itself. The mercury in the thermometer which is used for taking this temperature, owing to its previous exposure to the atmosphere, is considerably higher than the temperature of the water contained in the bucket, and the sailor, not being very careful as a rule in taking the temperature, submerges it only for a couple of minutes, which will not under any circumstances give it time to descend to the actual temperature of the water obtained therein. I have known cases myself where supposedly accurate readings have been given me that were "taken" with a broken thermometer.

It is now time that such crude methods for a ship's guidance in the path of ice should be eliminated. The only way in which such information can be of assistance to the navigating officer of the vessel is:

1.—Human fallibility must be entirely eliminated.

3.—The sea temperature should not be taken from the surface, but at a considerable distance below the surface.

4.—The atmospheric conditions and changes, when encountered, should also be automatically transmitted to the officer in charge.

It is a well-known fact that sailors can smell ice. The sailors in the crow's-nest of the *Titanic* knew that they were in the vicinity of ice, and they even had a very great drop in the sea temperature prior to the vessel's collision with the berg, but, owing to the temperature being taken from the surface, sudden drop was encountered too late to avert the sad catastrophe.

Having knowledge of the method in which temperatures were taken aboard ship, immediately after the loss of the *Titanic* I set my mind on a method that would accurately determine temperatures and transmit same to the officer in charge. Therefore, thirty-six hours after the loss of the *Titanic* I paid a visit to Mr. F. W. Smith's office, in this city, with the plans and drawings of my Frigidometer, and instructed him to push it with all speed through the patent offices in Washington and the various European countries.

My first installation of this apparatus was made on the *Mauretania* in July of last year, just about eleven weeks after the occurrence of the disaster previously mentioned. My wife and self went over on the *Mauretania* to England. On the way across every temperature encountered, both atmospheric and sea, was faithfully recorded and transmitted to the captain on the bridge.

My apparatus was also the means of pointing out to me another aid in the navigation of the ship, apart from its valuable assistance in locating icebergs at sea. During the voyage of the *Mauretania*, we found that on approach to shoal water the difference in sea temperature was so great from that at considerable depth that it informed the captain the moment he was off the Banks of Newfoundland, the moment he entered and left the Arctic current, the moment he entered and left the Gulf Stream, the

the *Mauretania* leaving Liverpool on the following Saturday. The *Adriatic* sighted an iceberg one day at noon in a certain latitude and longitude. Knowing that the *Mauretania* was coming up astern of her at the rate of twenty-five knots per hour, the captain of the *Adriatic* flashed a Marconigram advising Captain Turner, of the *Mauretania*, that he had passed a huge iceberg, giving the latitude and longitude. This Marconigram was received by the captain of the *Mauretania* and acknowledged by wireless—thanking the captain of the *Adriatic*. In the early hours of the next morning the *Mauretania* was under reduced speed, as they were drawing near the vicinity of the iceberg. The captain of the *Mauretania* bore to the south'ard to avoid the berg. The berg was also bearing south'ard as it seemed to meet the *Mauretania*. During the time the *Mauretania* was under reduced speed, about 2.00 a.m., they encountered a dense white fog. The officers knew that they were in the vicinity of ice, owing to this dense fog due to the condensation of the surrounding atmosphere. Suddenly, and without warning, the Frigidometer pealed forth an announcement and flashed a red signal that a sudden change had been encountered in the temperature of the sea at 36 ft. below the surface. No sooner had the Frigidometer been placed at a lower degree, than the atmospheric alarm gave warning of a decided drop in temperature. From time to time changes in temperature occurred, indicating that they had crossed the well defined line between warm and cold water which was influenced by the enormous mass of ice. The captain starboarded his helm and found that in this direction he got a greater and more rapid decrease. He ported and got an increase, which showed him plainly that he was getting away from the berg. The *Mauretania* still continued under very slow speed, and, shortly after the course had

tically the first voyage after its installation. I was in London at that time, and, when the papers arrived in that country, informing me that my Frigidometer had detected ice at a distance of fifteen miles from the ship, I would not believe it. On the next arrival of the *Mauretania*, I went to Liverpool, from London, and interviewed the captain, who informed me that it was absolutely true, and that the ship was at least fifteen miles from the berg when he had his first alarms. Since then I have received numerous letters from the captain of the *Mauretania* advising that the Frigidometer is doing all we claim for it and that it is a valuable aid to safe navigation.

Recently I had the installation placed, at the request of the White Star Line, on their *Baltic*, and also have many other installations to make on trans-Atlantic liners on my return to Europe in the course of a week or two.

Another important feature has been neglected in up-to-date ships, and practically the same methods are employed today as in the days of Fulton and his *Clermont*. When steam was first introduced for the propulsion of vessels, the accurate transmission of signals between the captain on the bridge and the engineer below in the engine room was carried out by means of a cow bell and gong. Today, the same methods are employed in our coastwise passenger vessels. For the safe and efficient handling of vessels, the engineer and captain must be kept in such close touch with all information transmitted from one to the other that the present method is not in keeping with the steady advance in engineering. The captain may give a correct signal to the engineer to reverse his engines, and the engineer, at times, through error, will put his engines ahead. The captain hears the vibrations of the engines started below, but has nothing to show him the direction until the

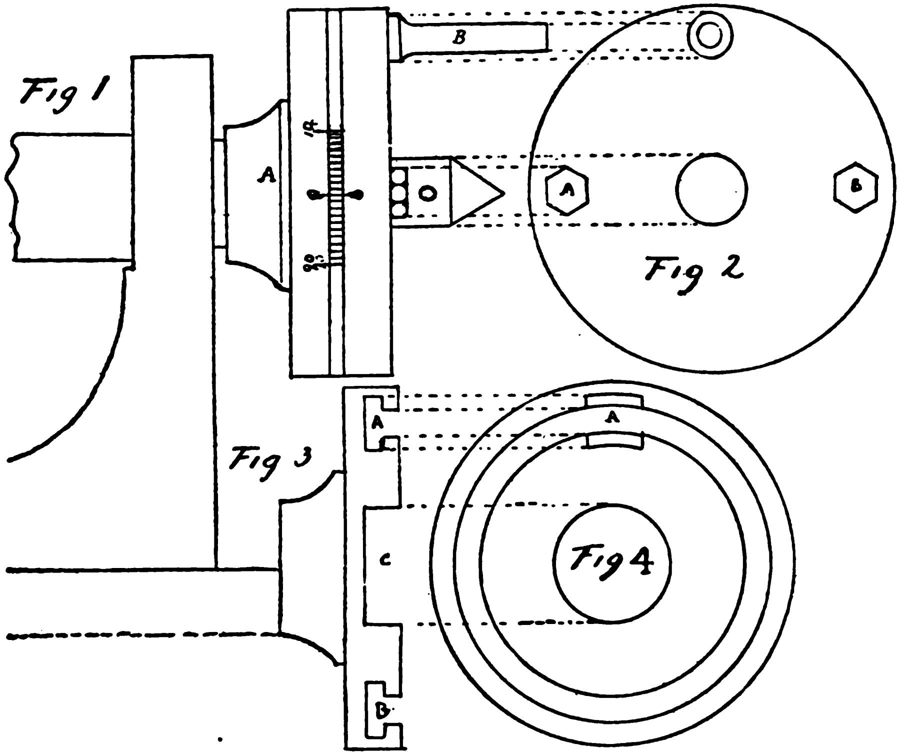
CUTTING MULTIPLE THREADS

J. H. EVANS

The original mode, and one still pursued by some, is to divide the wheel on the mandrel into the desired number in accordance with the threads required. To effect this is not a difficult matter, but is has its drawbacks. Suppose it is desired to produce a screw with four threads, the wheel, whatever it may be that is attached to the mandrel, is divided into four and distinctly marked. The first thread having been cut, the radial arm is released and the wheel turned one quadrant and gently lowered

face and turned all over perfectly true. The material selected may be either gun metal or cast iron; I think the first is preferable.

Having the body thus turned, a *T*-shaped groove must be turned in the front as shown in *AB*, Fig. 3, and a recess turned in the front *C*, to receive the conducting fitting of the front plate. These fittings must be as perfect as it is possible to make them, as the corresponding accurate movement of the front plate depends entirely upon this fitting.



to gear with that from which it was removed, the same having been marked to insure the accuracy of the regearing. This means will, as I say, effect the purpose; but I do not think it is used, except in very remote parts, and may be considered obsolete.

The dividing chuck is now generally adopted. We will take first the center dividing chuck most generally used for engineering purposes. It we study Figs. 1 and 2 it will be at once seen that this chuck is made in two parts, the base *A* being well bedded home to the mandrel

I have shown these parts in section as well, to illustrate more clearly the internal fittings.

The back plate must now have a recess cut out in the groove, as shown in *A*, Fig. 4, to admit the two steel fittings to hold the clamping-screws *A* and *B*, Fig. 2, which secure the two parts together. The readiest manner of getting this out will be to drill a few small holes through the part that is to be cut away, then break them one into the other with the point of a round file, and finish them off to the side of the tee-groove with a

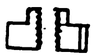


Fig. 5

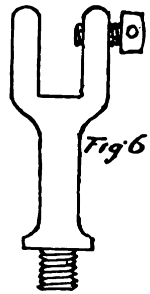
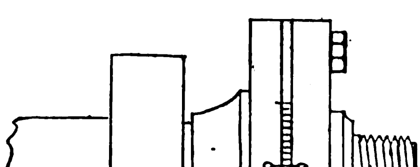


Fig. 6

series of other and smaller files. This may take a little time, but it is the most handy in many cases. Another way, if preferred, will be to have a small rose drill fitted to a drill-spindle, and adjust it on the slide-rest to the required position, and move the plate backwards and forwards as far each way as the size of the recess necessitates. It is not important that the ends of the recess be squared; they can be left as formed by the diameter of the drill. The steel block that moves round in the recess only requires to pass into the groove. As shown in Fig. 5, these fittings are tapped right through, and the clamping bolts have a plain fitting through the front plate, so that when they are in their places and are released the plate will move round to the desired position, when the bolts are again set up to secure the two together. The back plate is thus divided into a series of equal divisions, and the zero distinctly marked, a corresponding reading line being marked on the front plate, as shown in Fig. 1.

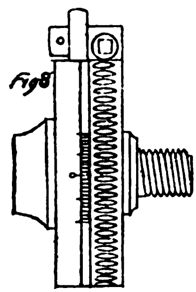
The center is screwed on to the front plate, and can be replaced by a female center, if required for any special purpose. The length of the chuck necessitated by its construction prevents the use of the centre as fitted to the front of the mandrel nose. This, however, is found to be not the least detrimental, as when



carefully and correctly made, the axial truth is quite as accurately maintained.

Another very useful addition will be found in a second driver to replace *B*, Fig. 1. This is illustrated in Fig. 6, and will be seen to have the extremity forked, or open, which enables the carrier upon the work to be passed into it, and secured by the fixing-screw; this obviates the care otherwise required to keep the carrier in contact with the driver when starting a fresh cut. The chuck made in this way can be continually employed; but I think it preferable to keep it strictly for its intended purpose—that of cutting screws requiring multiple threads, using the ordinary one for general purposes.

Fig. 8



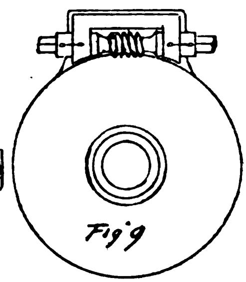


Fig. 9

We have two other methods to adopt in fitting up this particular type of chuck. It is very often required to cut a series of threads up a piece of work that is already held in a cup chuck or on a soldering plate. This being the case, it is essential to have a second chuck made, as illustrated in Fig. 5. This, it will be observed, is precisely the same construction as that previously described, the only difference being the replacing of the running center by a screwed nose to correspond with that on the mandrel. This is more especially useful in the case of amateurs, and has been found a considerable advantage, and dispenses with the necessity for removing and recentering the work in hand, and thus saves much valuable time.

We may go still further in the perfection of this addition to the lathe when required for special purposes. I received instructions in one instance to make one

one for their own use. It will be seen that as shown it is provided with a worm-wheel adjustment, for the purpose of further insuring the accuracy of the numerous settings required, when about to cut a screw with a greater number of separate threads, a multiple of something like ten or more for the work in hand being required. Any number can, of course, be obtained from the foregoing chucks already detailed, but that shown in Fig. 8 affords greater facilities for what in the case referred to became necessary—the greatest accuracy obtainable. It will be seen that the fixing-screws *A* and *B*, Fig. 2, are now dispensed with, the front worm-wheel being retained in its bearing and close contact with the face of back plate, in the same manner as the usual spiral dividing chuck—viz., a screw fitted to the back of the wheel.

In order that the bearing surfaces of the two plates may be more substantial, they are made to cover throughout the entire diameter as seen in Fig. 8, the back plate being divided, and a small reader fixed on the worm-wheel. The plate may be divided in any number preferred, in Fig. 1 one hundred divisions are engraved, while in Fig. 8, a worm-wheel of ninety-six teeth, ten to the inch, is, I think, quite all that is necessary, being divided at each thread, and the tangent screws each divided into four, the initial or reading lines both in accurate agreement when the indicator on the wheel points to 0 in the back plate—*vide* Fig. 8.—*English Mechanic and World of Science.*

THE SELECTION OF EXPLOSIVES

The United States Bureau of Mines has just published Bulletin 48, "The Selection of Explosives used in Engineering and Mining Operations," by Clarence Hall and Spencer P. Howell. It deals with the characteristic features of the principal explosives used in engineering and mining operations, and especially with the tests that show the suitability of different classes of explosives for various kinds of work. The bulletin is published as one of a series dealing with tests of explosives and methods of reducing the risks involved in the use of explosives in mining work.

In large engineering projects and in mining operations requiring the use of explosives the selection of a suitable explosive from the many varieties offered for sale is of fundamental importance. The various considerations involved in the selection of the proper class of explosive for the blasting to be done are given. Many explosives suitable for quarry work have been proved unsuitable for use in deep mines or in close workings. In metal mining and in driving tunnels, the character of the gases evolved by the explosive on detonation is an important consideration. An explosive for use in gaseous or dusty coal mines must be formulated and compounded so that its flame temperature and the height and duration of its flame are reduced enough to permit its being used with comparative safety. In wet workings or in submarine blasting, explosives impervious to moisture are requisite. In extremely cold climates, explosives that do not require thawing are desirable, provided they are equally good in other respects. An essential requirement of all explosives, especially of those for use in tropical countries, is that they shall remain stable without change in chemical or physical characteristics.

Because of the varying conditions in the different projects on which explosives are used, the fact is emphasized that some characteristics of explosives are of much importance in certain classes of work and of little or no importance in others. As practically every class and every grade of commercial explosive is used in open-air work to meet varying conditions, the authors indicate the method of manufacture, give typical composition of, and state the use to which each of the following explosives is best adapted: black blasting powder, granulated nitroglycerin powder, "straight" nitroglycerin dynamite, low-freezing dynamite, ammonia dynamite, and gelatin dynamite.

Black blasting powder is stated to be best suited for work in which a gradual pushing or heaving effect is desired, such as excavating cuts, quarrying soft rock or stone, and especially in quarries where large blocks of building stone are

sought, and in order to obtain the maximum efficiency the charge must be well confined by suitable stemming. Granulated nitroglycerin powder is more effective and gives better results than black blasting powder in soft and seamy rock or in material that does not sufficiently confine the gases evolved. "Straight" nitroglycerin dynamites, as a class, develop greater disruptive force than any of the other commercial classes of explosives tested, and for this reason they should be used for producing shattering effects or for blasting very tough or hard materials whenever the conditions permit. If the "straight" nitroglycerin dynamites are found to be too violent for certain classes of work, the low-freezing dynamites or the ammonia dynamites, which have lower rates of detonation and hence less disruptive effect, are recommended. The low-freezing dynamites have the advantage of not freezing until exposed to a temperature of 35 degrees *F* or less, but, like all nitroglycerin explosives, after they become frozen they must be thawed before use in order to insure the most effective results. As the ammonium nitrate used in ammonia dynamite is deliquescent, this class of explosive absorbs moisture more readily than other dynamites, therefore it is emphasized that care should be observed when storing this class of explosives in wet or damp places. The gelatin dynamites have been used to a large extent in wet blasting, such as in the removal of obstacles to navigation and in deep workings, and, as a general rule, they are best suited for these purposes.

The products of combustion of explosives used in closed work is said to be of vast importance, because in such work large quantities of explosives are generally used and they may produce gases on detonation will result in its being commercially manufactured.

This special gelatin dynamite was tested at the Pittsburgh testing station of the bureau, in a limestone mine at West Winfield, Pa., and in a zinc mine at Franklin Furnace, N.J., the detailed results of which are reported in bulletin 48.

The bulletin points out dangers arising from the burning of high explosives by showing the great increase in the percentage of poisonous gases evolved.

The authors describe the method of blasting followed at Lock No. 1, Monongahela river, as an example of submarine operations, giving the difficulties encountered, showing the causes of misfires, and the methods used for overcoming these difficulties. The tests incident thereto, showed that variation in the cross-sectional area of the bridge of an electric detonator was an important factor in its failure to explode when in series with other electric detonators.

The bulletin closes with a table showing for nine explosives of different classes and grades the relative potential energy, disruptive effect, which bears a close relation to the percussive or shattering force of explosives, and propulsive effect, which corresponds to the pushing or heaving force.

Copies of this bulletin may be obtained by applying to the Director, Bureau of Mines, Washington, D.C.

Cast Iron Brazing

Nearly everyone has had at one time or another a broken piece of cast iron to repair, which, owing to its shape, etc., required either arduous patching, or had to be sent to one of the companies who make a specialty of this kind of work. By using the following brazing process considerable expense and delay can be avoided. The pieces of iron are first ... if they were steel

ELECTRO-DEPOSITION OF PLATINUM

Use of Platinum in the Arts Rapidly Increasing. Platinum Plating a New and Interesting Operation

The present extensive use of platinum in jewelry has given rise to a demand for platinum plating. This demand has also been in existence in other lines in which platinum is employed, and it is believed that many useful and economical goods can be made by its service.

Platinum plating is not a difficult operation, particularly if carried out on a small scale, as it usually is. The solution must be used hot, which is, of course, an objection to large installations, but is not in the case of small ones. The solution employed is an acid one, and for this reason must be used in a porcelain or glass vessel. This feature, too, is not objectionable, as gold is deposited every day under the same conditions.

There are a number of solutions for the electro-deposition of platinum, but the best is that first proposed by Roseleur, the celebrated electro-metallurgist of Paris. This solution has been found to give excellent results and is not difficult to work or to make up. With a little chemical knowledge and experience in electroplating, an operator will have no difficulty, but will be able to turn out a good job of plating right along.

This solution has the advantage over the others proposed (whether they are in commercial use or not cannot be ascertained) in that the platinum has no tendency to separate out as the bath is standing idle. In the other solution, this is an objection, and the platinum has a tendency to separate spontaneously, and thus in time render the solution useless.

The solution about to be given, and which was first used by Roseleur, has been slightly modified. Phosphate of ammonia as recommended by him as one of the ingredients has been left out, as it is difficult to obtain. The same result, however, is obtained by using phosphoric acid and then adding ammonia.

To make the platinum solution for the electro-deposition of platinum, proceed as follows:

strong nitric acid. The amounts are fluid ounces. The platinum should be as pure as possible and free from iridium, as the latter metal not only causes the platinum to dissolve with great difficulty, but the iridium chloride interferes. The pure platinum chloride may be purchased and the amount made from 1 ounce of platinum or that containing 1 ounce of platinum should be used. (2 oz. 14 dr. 16 gr. avoirdupois of crystallized platinum chloride are the chemical equivalent of 1 Troy ounce of metallic platinum. Three ounces of the salt is a sufficiently close approximation in practice.—*Eds. Electrician and Mechanic.*)

The platinum is placed in a porcelain dish and heated gently with the aqua regia until it is dissolved. When this is done, heat the dish gently for some time until the platinum chloride that has now been produced becomes thick and syrupy. The object of this evaporation is to remove the excess of acid, but the platinum chloride should not be evaporated until dry, as it is then partially destroyed. When it is thick and syrupy, the right condition has been obtained. There is now obtained pure platinum chloride, free from an excess of acid.

When cool, dissolve this platinum chloride in 3 qts. of water (or 3 liters) and to it add 15 ounces (fluid) of a 50 per cent. phosphoric acid (or 450 c.c.). Next add ammonia until the solution smells rather strongly of it, when a yellow precipitate of the double phosphate of platinum and ammonia will be thrown down. This precipitate should *not* be filtered out, but is allowed to remain in the solution.

Now dissolve 50 ounces (or 1,500 grams) of sodium phosphate in 3 quarts of hot water (or 3 liters). Now pour it with constant stirring into the platinum solution containing the ammonia. The mixture is now boiled for a short time until no more smell of ammonia is given and the solution, which was previously alkaline, turns blue litmus paper red.

yellow liquid also becomes nearly colorless as this reaction takes place. The solution is now ready for use. The amount should be about 1½ gallons, or about 6 liters. If desired, the amounts can, of course, be reduced in order to make a less quantity. It will be seen that the solution is rather rich in platinum, but this is necessary in order to obtain good results.

The solution when used for platinum plating should be heated to about 150–180 degrees F. The hotter it is, the better it seems to work. A cold solution will not work.

As an anode a piece of platinum is preferable, although not entirely necessary. Carbon may be used if desired. If a platinum anode is used, however, there is no action on it and the solution cannot be fed from it. To replenish the solution, fresh platinum chloride must be introduced. The platinum anode is never attacked, and may be used indefinitely without injury.

A high current density is necessary and the voltage should be maintained at 5 or 6. At a less votage the electro-deposition does not take place.

The platinum cannot be deposited upon iron or steel direct, but they will have to be coppered, nickeled or silvered before it is done, when no difficulty will be experienced. The electro-deposition on brass, copper, silver, nickel, bronze or gold takes place readily. It is useless to coat the articles with a slight film of mercury in a "quick-dip," as this seems to do no good. The deposit is put on the metal direct, but it is needless to say that extra care should be taken to produce a clean surface before the electro-deposition of the platinum.

The deposit forms immediately and in a few seconds a bright deposit is obtained if the metal underneath is highly buffed. The platinum deposit takes the nature of the metal underneath and upon highly long deposition. The deposit seems to come dense under such circumstances.

The deposit of platinum is quite hard and of the regular platinum color. It is so hard that it cannot be scratch-brushed by a brass scratch-brush, but one of steel must be used. Even then, it seems to remove particles of steel, but these can be taken from the surface by muriatic acid (equal parts of acid and water). The platinum deposit cannot be burnished, as it is too hard. It must be buffed, and the same compositions used for hard nickel employed. Vienna lime is good for this purpose. The best results, however, seem to be obtained by highly buffing the base metal and then depositing the platinum upon it as a light coating. It will then be sufficiently bright and will not need buffing.—*The Brass World.*

Dangers of the Sea

(*Continued from page* 376)

just as soon as the captain rings a bell and the engines start, the controlling levers are on the bridge, but, should a vessel pick up and gain momentum in the wrong direction, it is impossible to slam on brakes and stop the vessel. With her great body she must go and there is no stopping until something "harder than the ship" comes in contact with her.

Such thoughts inspired me with the idea of the now well-known McNab Direction Indicators. This instrument was invented by me three years ago, and today it is hard to find a corner of the earth, under any flag, where the McNab Indicator is not doing its duty: informing the captain of every engine movement, speed at which the engines are turning, and should the engines start in the wrong direction, before the vessel can gain momentum the error is rectified.

I have had letters from many stating

A SMALL FAN MOTOR

LEON BURGOYNE

This article describes the construction of a double-acting small electric fan motor, there being two armatures and flywheels. It is a machine which will look very pretty if carefully made and finished, and has the great advantage of not requiring any special castings, being easily made by an amateur with the aid of a few tools. We will take first the field magnets. Procure 1 doz. hardwood bell bobbins (unwound), 1¼ in. outside length, ¾ in. flange, ¼ in. hole; also 1 doz. soft iron cores for same. These can be bought ready made, and will be found to have one end screwed for fitting bell about 2 in. over at each end of the wire for connections. Finally, when all the bobbins are wound, give them a coat of shellac varnish and set aside to dry thoroughly. Now to deal with the motor frame. This consists of two pieces of 3-64 in. sheet brass cut to the shape and dimensions shown, Fig. 1. The circular part must be divided into twelve even parts exactly, and where the dividing lines cut the inner circle (see dotted circle Fig. 1) ¼ in. holes must be carefully bored (see Fig. 1), also ⅛ in. holes at all the points marked on the edge of outer circle. As the thorough

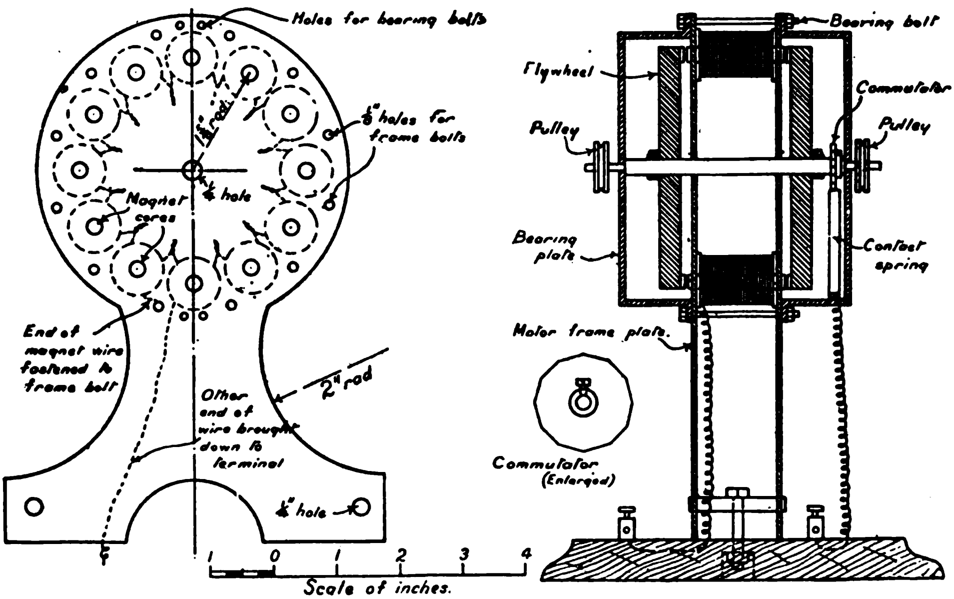


Fig. 1. Side View Fig. 2. Section

A Small Electric Fan Motor

magnet frames. These screwed ends are cut off the length of the screw, and carefully filed perfectly flat till the length of core is 1⅜ in. Now carefully drive the cores through the bobbin holes, which will leave 1-16 in. projecting from each end. If the cores are a trifle too large for the holes, file a little. On no account use too much force in driving, or the bobbins will probably split. The bobbins should now be carefully wound with No. 20 silk- or cotton-covered wire. Well soak the wire in melted paraffin before commencing, and cover each layer as wound with thin paper, leaving efficiency of the motor depends on the accuracy of dividing the circle, to save spoiling the brass plates by corrections in case of error the best plan would be to cut out a circular piece of note-paper 2⅜ in. radius, and describe a circle 1⅝ in. radius, and divide as required. Paste the paper firmly on the circular part of one of the plates, place the other plate underneath the latter and clamp together; carefully drill all the holes ¼ in. and ⅛ in. as marked right through. These should be neatly done, seeing that the edges are not burred, or else when putting together there will

be trouble. Hammer the brass with a wooden mallet till dead flat; then thoroughly clean, polish and lacquer both sides, and lay by to dry. When dry, lay one of the plates flat on a clean surface, and place each of the bobbins upright (either end up) with one end of each core resting in one of the ¼ in. holes. The magnets will then be in a circle (see small dotted circles, Fig. 1). Now join the ends of wires as shown—it does not matter in what order—by baring them and twisting together, and after cutting off any superfluous wire bend inwardly in such a way as not to touch either of the plates when clamped together, which latter must now be done by placing the other plate on top of the bobbins with cores in the holes, as before, and passing 1½ in. bolts through the outer holes, and tightening all up with nuts, one of the wire ends being securely fastened after being bared, to one of the lower bolts. In screwing up the nuts, care should be taken not to do it too tightly, which would have a tendency to make the plates bulge slightly in the middle.

We now come to the armatures and fly-wheels. Two of these will be required—one for each end of the field magnets. For the fly-wheels get two light-weight brass wheels 3½ in. diameter, with center hole 3-16 in. For the armature the easiest plan will be to get a few cogging laminations with 12 cogs and 3½ in. diameter, or the same could be cut out of thin, soft sheet iron. These armatures are then soldered at the tips of the cogs to the fly-wheels. The bearings should next be made of ½ x ⅛ in. strip brass, to shape shown Fig. 2. The shaft holes being ⅛ in., these bearings must be drilled at each end to take two ⅛ in. bolts, which pass through both plates. The bolt holes in the bearings should be made somewhat larger than is or commutator. This consists of a circular piece of ⅛ in. brass or copper, ¾ in. diameter, divided into twelve parts (see detail sketch), and a 3-16 in. hole bored in the center; a short piece of brass tube with hole 3-16 in. being soldered to one side and drilled and tapped to take a small setscrew for adjusting the commutator on the spindle. The hub of each fly-wheel should be drilled and tapped for a small setscrew for securing to the shaft; if the hub is not deep enough for screwing a short piece of tubing (3-16 in. hole) may be soldered on and screw fitted, as shown at Fig. 2. Now place the spindle through the center holes in plates; place, the left-hand fly-wheel on, then the right-hand one, and the commutator, and finally put on the bearings and secure to the frame by means of bolts and nuts. Now push each fly-wheel up to the magnet cores till the armatures touch them. If some project a little too much they must be carefully filed down. If they touch all one side of each armature, but not the other, the bearings must be slightly shifted so as to bring the faces of the armatures perfectly parallel with the magnet cores. This part of the fitting will probably require a little patience, but is necessary to the efficient working of the motor. When you have succeeded in getting the cores and armatures perfectly adjusted so that they practically touch each other at all points, screw up the bearings tight. Now draw back the armatures just enough to clear the cores when revolving; the closer, they are, of course, the better will the motor work. The setscrews will secure the armatures to the shaft. A contact spring of thin brass for the commutator is made and fitted on the lower part of the bearing, from which it must be insulated in the usual way. The stand for the motor is a polished block of wood of suitable size fitted with two terminals, the frame

other terminal; but take care that there is no electrical contact between either wires or the motor frame, as this would be fatal to its working. A fan can best be made out of a single piece of thin sheet brass having a small bit of tube with setscrew soldered to its center for securing to the shaft. The pieces for the vanes are cut and then twisted at a slight angle so as to strike the air when revolving. The motor will take an intermittent current of about 1 amp. or less at 2 volts. Not more than 4 volts should be used, or the insulation might be destroyed.—*The Model Engineer and Electrician.*

A METHOD OF SECURING CRANK-PINS, ETC.

CLIVE NICHOLSON

The following is a modification of a well-known method of fixing crank-pins, axles, etc., which I find very useful. The drawings are self-explanatory, the shape of the component pieces being clearly shown. The threads on the reduced portion of *A* and on the outside of *B* may be cut with Whitworth standard dies, though *A* need not be so much reduced if a gas thread is used on *B*, and a stronger job results. In putting together, *B* is first screwed into *C* as far as it will go; the threaded shank of *A* is then screwed into *B* till the collar (or cone) is fairly home; *B* is then turned back so as to screw it *out* of *C*. The result is that as *B*, owing to its coarser thread, tends to leave *C* faster than it pushes *A* away from itself, *A* is drawn on to its seating by an amount due to the difference in the pitches of the two threads. When tightened up, everything is very firmly locked. The usual method of making such a joint is to put the fine thread on *B* and the coarse thread on the reduced portion of *A*, and the joint is tightened by screwing *B* into *C* instead of out of it. Besides the obvious advantage of having the fine thread on the smaller part of the work, bringing in standard taps and dies, the very awkward calculation is avoided with reference to the length of the screw threads required on *A* and *B* to bring everything into position when tightened up.

Fig. 2 shows a method of making the joint with a head on the pin and everything else flush. Though not so strong a job as that shown in Fig. 1, it has its advantages.

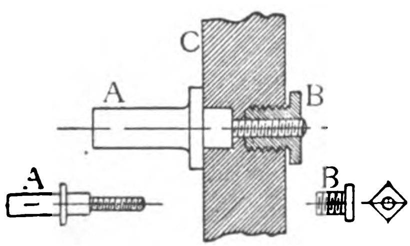


FIG 1.

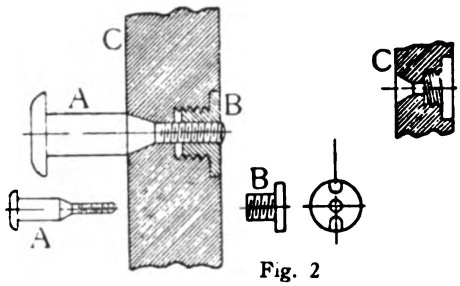


Fig. 2

Important Wireless Work

FRENCH AND AMERICAN EXCHANGE OFFICERS TO ESTABLISH EXACT DIFFERENCE IN LONGITUDE

With the arrival at Washington, March 17, of four French officers prominent in the army and navy of France and in European scientific circles, experiments are to be undertaken through the medium of the powerful navy wireless station at Arlington, Va., and the station of the Eiffel Tower in Paris, to establish the exact longitude between the two countries. The work is of great importance, for when similar data is obtained by other nations, the information will permit for the first time the drawing of a true map of the world. The French officers are Lieutenant Ludovic Driencort and Lieutenant Charles de Vaisseau of the navy, and Colonel Gustav Ferrie and Captain Paul Levesque of the army. They have brought with them a number of highly sensitive instruments, similar to those which will be used in Paris so that the work at both ends will be synchronous. The naval observatory will join in the tests and exact time here will be flashed at intervals to Paris as part of the program. While here the French officers will be the guests of the Government. They have been quartered at the Army and Navy Club, and a number of entertainments already have been arranged for them.

WHAT ELECTROCHEMISTRY IS ACCOMPLISHING*

JOSEPH W. RICHARDS
(*Professor of Metallurgy, Lehigh Univ.*)

My theme is to depict for you, as clearly as I may be able, the part which electrochemistry is playing in modern industrial processes. I have no exhaustive catalogue of electrochemical processes to present, nor columns of statistics of these industries; but my object will be to classify the various activities of electrochemists and to analyze the scope of the electrochemical industries.

SCOPE OF ELECTROCHEMISTRY AND ELECTROMETALLURGY

Chemistry is the science which investigates the composition of substances and studies changes of composition and reactions of substances upon each other. As an applied science, it deals chiefly with the working over of crude natural material, and its conversion into more valuable and more useful substances.

Some common examples, to illustrate this statement, are the conversion of native sulphur into sulphuric acid, the manufacture of soda and hydrochloric acid from common salt, the conversion of phosphate rock into superphosphate fertilizer, etc. Several pages would not suffice merely to catalogue the great variety of chemical industries; immense amounts of capital are invested in them and they are some of the most fundamental industries in their relation to supplying the needs of a rapidly advancing civilization.

Metallurgy is the art of extracting metals from their ores, and of purifying or refining them to the quality required by the metal-working industries. It is a branch of applied chemistry. The metallurgical industries form a highly important part of our national resources; on them we depend for iron, steel, copper, brass, gold, silv

agency in accomplishing chemical operations, and it has not only succeeded in facilitating many of the most difficult and costly of chemical reactions, but it has in many cases supplanted them by quick, simple and direct methods; it has even, in many cases, developed new reactions and produced new materials which are not otherwise capable of being made. A few examples will illustrate these points: Caustic soda and bleaching powder are made from common salt by a series of operations, but the electrical method does this neatly and cheaply in practically one operation; lime and carbon do not react by ordinary chemical processes, but in the electric furnace they react at once to form the valuable and familiar calcium carbide; carbon stays carbon except when the intense heat of the electric furnace converts it into artificial graphite. The list of such operations is a long one, and it may be said that the chemist has become a much more highly efficient and accomplished chemist since he became an electrochemist, and he is becoming more of an electrochemist daily.

Electrometallurgy applies electric energy to facilitating the solution of the problems confronting the metallurgist. Its birth is but recent, yet it has rendered invaluable service; it has made easy some of the most difficult extractions, has produced several of the metals at a small fraction of their former cost, and has put at our disposal in commercial quantities and at practicable prices metals which were formerly unknown or else mere chemical curiosities. It has, further, refined many metals to a degree of purity not previously known. The metallurgist is rapidly appreciating the possi-

and metallurgy, and is rapidly increasing in importance. It is a new art; people are really only beginning to understand its principles and to appreciate its possibilities; it is an art pursued by the most energetic and enterprising chemists, with the assistance of the most skilled electricians. Some of its most prominent exponents are electrical engineers who have been attracted by the vast possibilities opened up by these applications of electricity. The chemists have worked with electricity like children with a new toy, or a boy with a new machine; they have had the novel experience of seeing what wonders their newly applied agency could accomplish, and it is no exaggeration to say that they have astonished the world—and themselves.

THE AGENTS OF ELECTROCHEMISTRY

The operating agent in electrochemistry is, of course, electric energy, which may be used in three classes of apparatus, *viz.*:

I. Electrolytic apparatus.

II. Electric arcs and discharges in gases.

III. Electric furnaces.

I

Electrolytic apparatus and processes use or utilize the separating or decomposing power of the electric current. Whenever an electric current is sent through a liquid material which is compound in its nature, *i.e.*, a chemical compound, the current tends to decompose the compound into two constituents, appearing respectively at the two points of contact of the electric-conducting circuit with the liquid in question, *i.e.*, at the surface or face of contact of the undecomposable conducting part of the circuit with the decomposable part. If the current has a definite direction the constituents appear at definite electrodes. The action is simply the result of the current passing being regarded only as a tendency or a determining cause which practically results in the reactions actually taking place.

This agency is an extremely vigorous and potent force for producing chemical transformations. It enables us, for instance, to split up some of the strongest chemical compounds into their elementary constituents, to convert cheap materials into much more valuable derivatives, to purify impure materials, in short, to perform easily some very difficult chemical operations and in some cases to perform chemical operations otherwise impossible. A description of all these various processes would take a volume, but a short explanation of a few of them will make the principles clear and suffice for my present purpose.

Electrolysis of water.—As a raw material, water may be said to cost nothing. Apply an electric current to it in the proper way, and it is resolved into its constituent gases, hydrogen and oxygen, as cleanly and perfectly as anyone could desire. These gases have many and various uses, and are valued each at several cents per pound. A whole industry has thus grown up, based on the simple electrolysis of water, to supply these two gases for various industrial uses. Europe possesses many of these plants; there are a few in the United States. The speaker has translated from the German a small treatise on this industry.

Electrolysis of salt.—Common salt, sodium chloride, is one of the cheapest of natural chemicals. It has some uses of its own, but centuries ago chemists and even alchemists devised chemical processes for transforming it into other sodium salts, such as caustic soda or soda lye for use in soap, soda ash or carbonate, for washing or glassmaking, and into chlorine bleaching materials. Chemical works operating these rather compli-

fighting for their existence. As for the electrolytic process, the salt is simply dissolved in water and by the action of the current converted into caustic soda at one electrode and chlorine gas at the other. By some special devices these are kept separate and collected by themselves, and the work is done. The principles involved are simplicity itself as compared with the older chemical processes, the only agent consumed is electric energy, and the products are clean and pure.

Chlorates.—These are salts used on matches and in gunpowder. Chlorate of potassium is a valuable salt with important uses. It is made from common cheap potassium chloride, in solution in water, by simply electrolyzing the solution without trying to separate the products forming at the electrodes. It is a simpler operation than the production of electrolytic alkali. Chlorate thus forms in the warm solution, and is obtained by letting the solution cool and the chlorate crystallize out. The ordinary chemical manufacture of this salt was tedious and dangerous; the electrolytic method has practically entirely superseded it.

Perchlorates.—These salts have more limited uses, but are made by expensive chemical methods. The electrolysis of a chlorate solution at a low temperature, without separating the products formed at the two electrodes, results in the direct and easy production of perchlorates. I cite this more to illustrate what I might call the versatility of the electrochemical methods, rather than because of its commercial importance.

Metallic sodium.—The caustic soda produced from salt can itself be electrolytically decomposed; this is the easiest way of producing metallic sodium. Sir Humphrey Davy discovered sodium by electrolyzing melted caustic soda, and at this moment several large works are working his method on an immense scale. The caustic contains sodium, hydrogen

Magnesium.—This is a wonderfully light metal, whose chief use is in flashlight powders. Its compounds are abundant in nature, but its manufacture by any other than the electrolytic method is almost impracticable. The operation consists in simply passing the decomposing current through a fused magnesium salt—a chloride of magnesium and potassium found in abundance in Germany.

Aluminium.—The most useful of the light metals; an element more abundant in nature than iron, yet which costs by chemical methods at least **$1.00** per pound to produce; electrochemistry enables the makers to sell it at a profit at **$0.25** per pound. This is probably the most useful metal given to the world by electrochemistry. Although the French chemist Deville obtained it by an electrolytic method in 1855, yet he had only the battery as a source of electric current, and the process was too costly. This very city of Pittsburgh was the real cradle of the electrolytic manufacture of aluminium, when in 1889 Mr. Charles M. Hall, with the financial assistance of the Mellons and the business assistance of Capt. A. E. Hunt, commenced to work his process up at Thirty-third Street on the West Side. The principle of the process is here again one of beautiful simplicity—when it is once made known. Aluminium oxide, abundant in nature, is infusible in ordinary furnaces, but easily melts and dissolves, like sugar in water, in certain very stable and liquid fused salts—double fluorides of aluminium and the alkali metals. On passing the electric current through this bath, the dissolved aluminium oxide is decomposed, appearing at the two electrodes as aluminium and oxygen, respectively. When all the oxide is thus broken up, more is added, and the operation continues. One of the most difficult problems of ordinary chemistry is thus simply, neatly and effectively solved by electrochemistry. The lower

burgh district. Many other factors besides cost of power bear on the question—cost of labor, abundance of labor, cost of carbon, coal for heating, various supplies, railroad freights, nearness to the consumers, and many other considerations must be taken into account. Aluminium is certainly destined to become the most important metal next to iron and steel, and, as far as one can now foresee, will always be produced electrochemically. To have accomplished the establishment of this one single industry would of itself have proved the usefulness of electrical methods and their importance to chemistry and metallurgy.

Refining of metals.—Unless metals are of high purity they are usually of very little usefulness. Electrolytic methods enable almost perfect purity to be easily attained, and in addition permit the separation at the same time of the valuable gold and silver contained in small amounts in the baser metals. Over **$100,000,000** worth of copper is electrically refined every year in the United States; the metal produced is purer than can be otherwise obtained, giving the electrical engineer the highest grade of conducting metal, while several million dollars' worth of gold and silver are recovered which would otherwise have to be allowed to remain in the copper. Again, the method is so simple that but a few words are necessary to set it forth in principle. The impure copper is used as one electrode—the anode—in a solution of copper sulphate containing some sulphuric acid; the receiving electrode—the cathode—is a thin sheet of pure copper, or of lead, greased. The electric action causes pure copper only to deposit upon the cathode, if a properly regulated current is used, while a corresponding amount of metal is dissolved from the anode. Silver, gold and platinum are undissolved, and remain as mud or sediment in the bottom of the bath; other impurities may go into the solution, but are not deposited on the cathode if the current is kept low. The cost of this operation is small, and the results are so highly satisfactory that 90 per cent. of all the copper produced is thus refined. Similar methods are in use for refining other metals; silver, gold, and lead are thus refined on a large scale; antimony, bismuth, tin, platinum, zinc, and even iron can be thus refined; the field is very inviting to the experimenter and to the technologist, and is rapidly increasing in industrial importance.

Metal plating.—All electroplating is done by the use of electrolytic methods similar to those just described. If we imagine the impure metal anode replaced by pure metal, and the receiving cathode to be the object to be electroplated, we have before us the electroplating bath ready for action. Everybody knows the value and use of gold, silver, and nickel plating; less well known are platinum, cadmium, chromium, zinc, brass, and bronze plating. These are among the oldest of the electrochemical industries. Electrotyping is only a variation of this work; also the electrolytic reproduction of medals, engravings, cuts, etc., and even the production of metallic articles of various and complicated forms, such as tubes, needles, mirrors, vases, statues, etc. The speaker has translated from the German a monograph concerning these last-named uses of the electric current. There is hardly opportunity here more than to catalogue these various branches of electrometallurgical activity. Pittsburgh people will be interested, however, in knowing that many of the newer buildings in this city contain thousands of feet of electrical conduits zinc-plated in a splendid fashion by electrolysis, at a works within a few miles of this city. At McKeesport tubes are coated on an immense scale, by dipping into melted zinc, but the electrolytic method is gaining a foothold, and we may live to see all galvanizing in reality practiced as it is spelled. The removing of metallic tin from waste tin scrap is also accomplished on a large scale by the application of similar principles. It is being operated at a distance from Pittsburgh, but your open-hearth furnaces use up annually thousands of tons of the scrap steel thus cleaned and saved for remanufacture into useful shape.

Without having mentioned or described more than a fraction of the electrolytic methods in actual industrial use, I hope that I have made clear the importance and extent of this kind of electrochemical processes. Assuming this, we will pass to the consideration of another entirely different and yet important class of apparatus and processes.

II

Electric arcs and high-tension discharges through gases are capable of producing some chemical compositions and decompositions which are very useful and profitable to operate. This is a branch of electrochemistry which has not been as thoroughly studied as some others, its phenomena are not as thoroughly under control as electrolysis and electrothermal reactions, and its possibilities are not as thoroughly understood or utilized.

Ozone is being made from air by the silent discharge of high-tension electric current. The apparatus is so far simplified as to be made in small units suitable for household use, ready to attach to a low-tension alternating current supply. The uses for the ozone thus produced are particularly for purifying water and air. It makes very impure water perfectly safe to drink and purifies the air of assembly halls and sick rooms, acting as an antiseptic. According to all appearances, this electrochemical doubling up of oxygen into a more efficient oxidizing form is developing into a simple and highly efficient aid to healthy living.

Nitric acid is an expensive acid made from the natural alkaline nitrate salts, such as Chili saltpeter. These nitrates are the salvation of the agriculturist, for they furnish the ground with the necessary nitrogen which plants can assimilate. The Chili "nitrate kings" have gained many millions of dollars, even hundreds of millions, in thus supplying the world's demand for fertilizer. But electrochemistry has another solution to this problem, which is rapidly rendering every country which adopts it independent of the foreign fertilizer. The air we breathe contains uncombined nitrogen and oxygen gases, which, if combined and brought into contact with water, furnish the exact constituents of nitric acid. The way to do this has been laboriously worked out, and the electric arc is the agent which does it. Air is simply blown into the electric arc, where it for an instant partakes of the enormous temperature, and on leaving the arc is cooled as quickly as possible. In the arc the combination of nitrogen and oxygen is effected to a certain extent, and the mixture is cooled so suddenly that it does not find time to disunite. The nitrogen oxides thus obtained are drawn through water, and this solution of nitric acid is run upon soda to produce sodium nitrate or on lime to produce calcium nitrate, the latter called nitrolime or "Norwegian saltpeter." These salts entirely replace the South American natural salt.

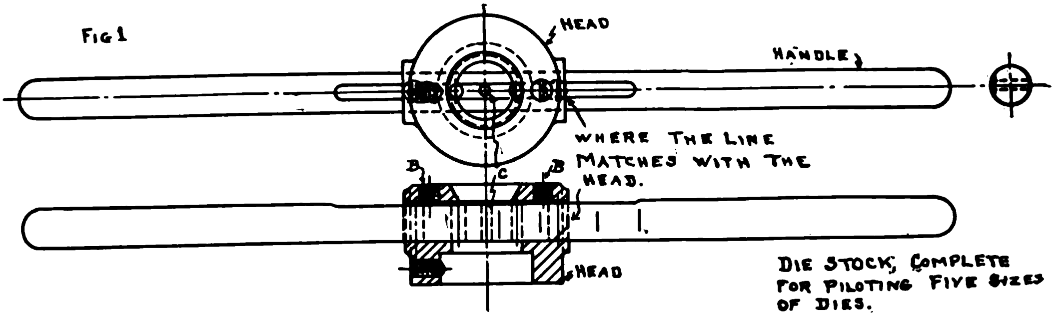
The materials used in this industry are air and lime, and to these is added electrical energy. Air is universal, lime cheap almost everywhere, and electrical energy is cheapest where water powers are most abundant. In Norway water power can be developed and electrical energy supplied from it at a total cost of $4.00 to $8.00 per horse-power year. Some other countries can do nearly as well. Under these conditions, almost every country can afford to make its own nitrates and so be independent of other countries for the fertilizer needed in peace and the gunpowder used in war. Norway felicitates itself already on being thus independent. Nearly 200,000 h.p. is being utilized there by a $15,000,000 syndicate, and the industry is spreading rapidly over Europe. The study of this problem, its solution, and the rapid development of this vigorous industry, is one of the most remarkable chapters in the history of recent industrial development. In this accomplishment electrochemistry has signally aided the agriculturist and demonstrably multiplied the food supply resources of all civilized and highly populated countries.

Boron is an element which has until recently defied the best efforts of chemists to isolate in a pure state. It is an element which may have important application in the manufacture of a high-class special steel—boron steel. Dr. Weintraub, one of our fellow members, has recently solved the problem of its production by an adaptation of the "oxygen-nitrogen" arc apparatus and utilizing the same principle of introducing the material into the arc and very rapidly cooling the products obtained. We mention this not because of its great commercial importance at present, but because it shows how the "arc method" may be of wide application in solving other difficult chemical problems. It has opened before us a new method in chemical science, and may give birth to many and various new chemical industries.

(*To be continued*)

SOME SCREW-CUTTING TOOLS

FRANK H. MAYOH



Cutting screw threads with a die is a job which most all mechanics are familiar with, and have had more or less trouble getting a true thread.

Although there has been quite a number of die stocks designed to pilot and hold the die, the accompanying sketches show two styles of die stocks which I believe will be new to most readers.

Fig. 1 shows what might be called a jobbers' complete die stock, as the handle has any number of holes desired, drilled through it to pilot the die while cutting various sizes of threads. Fig. 2 is a section of the handle used in this die stock and shows more clearly how it is used. For example, say, it is required to cut a 5/16 in. x 24 P.I. thread, the die is placed in position, and held in place by the screw *A*, next loosen screws *B*, Fig. 1, and slide the handle through the head until the line marked 5/16 in. x 24, Fig. 2, is in line with the end of the head, Fig. 1; now tighten the screws *B* and the die is ready for use. When using, the hole *C*, Fig. 1, is slipped over the piece to be threaded and acts as a pilot.

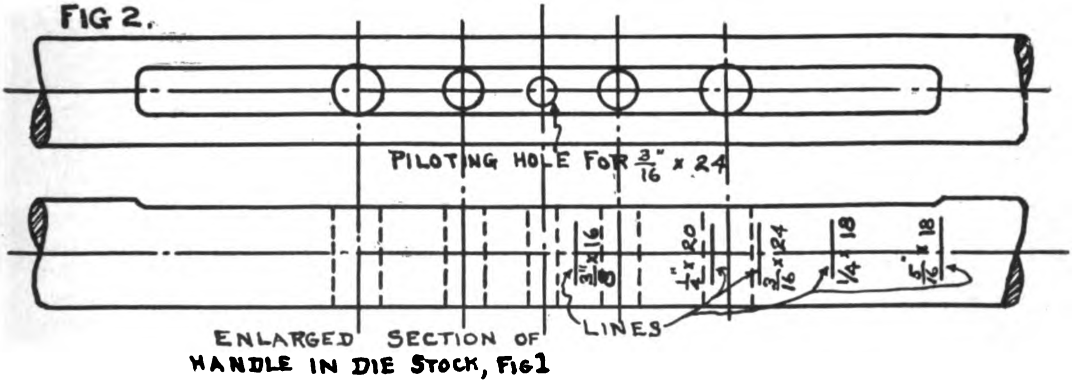


Fig. 3 shows a die stock designed for use in a lathe and carries a center hole for that purpose. When using, the die

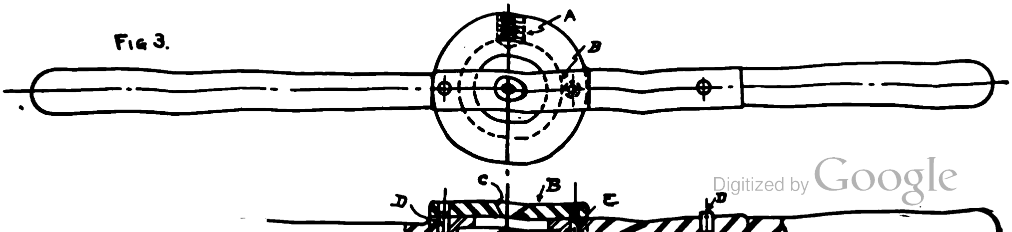
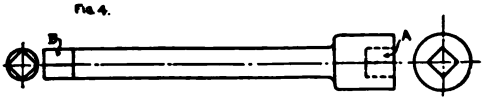


FIG. 4.



EXTENSION ROD FOR TAPPING

is held in place by the screw A, the loose piece B is in the position shown, the piece to be threaded is held by a chuck in the lathe, there is an ordinary 60-degree pointed center in the lathe tailstock, which has been used to support the work while turning; now instead of taking this tailstock center out and putting a pad in, the center hole C in the die stock is placed on the pointed center, which brings the die in line with the piece to be threaded, and the result is a true thread. If it is desired to thread a piece longer than the thickness of the die it can be done by swinging the loose piece B out of the way after the die has been started true and it will continue to cut a true thread. The two pins D are provided to keep this loose piece in the correct location, either when centralizing or when the piece has been swung out of the way, while the stud E is the pivot about which the loose piece swings.

Fig. 4 shows an extension rod for tapping holes in awkward places, where it is impracticable to use a tap wrench. The end A is slipped over the square head of the tap, and the tap wrench placed on the end B, and the hole is tapped as usual.

"VOLTITE" A SUCCESS

A particularly interesting invention is that of "Voltite" by Mr. Arthur T. Firth of New Zealand, which in brief is a method for the electro-plating of one metal on another by frictional precipitation. "The electro-plating of metals has grown rapidly to an industry of great importance," says Mr. Carl F. Woods, Secretary of Arthur D. Little, Inc., the well-known chemists and engineers of Boston, "but up to the present time there has been a great deal of economic waste, owing to the practical difficulties in the way of replacing the electro-deposited metal which is lost by the friction of constant use. A number of attempts have been made to solve this problem and several patents have been issued, but in most instances the coating possible of application to the metal by this process is so thin as to be of little value.

"A recent patent was issued for the deposition of nickel and other metals by friction which created considerable discussion in the electro-metallurgical world, but after a series of careful experiments it was found that the energy used in the process was so great in proportion to the results that the process possessed more theoretical than practical value.

"The process invented by Mr. Firth is electrolytic like other electroplating operations but very much simplified and it is claimed for the invention that anyone of ordinary intelligence can operate the process successfully. The compound itself, water and the slight friction used in applying it form a voltaic action, the metallic powder forming the anode, and the article on which it is to be deposited the cathode; hydrogen is developed which reduces the salt to a metallic state upon the article itself. The operation is applicable to gold, silver, nickel, copper, tin, and brass, and one of the most interesting applications is that of silver direct to steel. Perhaps the biggest field for its application lies in household use. The constant cleaning of silverware results in the removal of the deposited metal, whereas the use of 'Voltite' is claimed to increase the thickness of the metal instead of decreasing it and at the same time to preserve the desired appearance of the article."

Mechanical Drawing

(*Continued from page* 345)

in the use of instruments can trace another man's work, but the man with the ability to visualize and to put his ideas into such shape that they can be understood by the mechanic is the man who reaches the top of this profession.

(*Concluded*)

A TABLE WITHOUT JOINTS

In attempting to make furniture, even of a simple kind, many boys come to grief over the mortise and tenon, housing and other joints which have to be encountered if the article is going to stand the ordinary wear and tear of everyday use. Here, then, is an opportunity for making a useful table so designed that, while none of the joints mentioned are required, it will be neat, strong, lasting and serviceable.

The table is made of plain wood and is held together by means of small metal brackets, which can be purchased from any ironmonger.

The sizes shown in our sketch are as follows: The top is 22 x 17 x ½ in. The legs are 27½ in. long by 1 in. square (the total height of table thus being 28 in.). The legs are each set in 2½ in. from the edge of top, and thus the width over legs is 17 x 12 in. The shelf is 16½ x 11½ in. (½ in. less than width over legs), and from floor to upper face of shelf is 16 in.

These sizes may be varied as required. The table may be a little larger or a little smaller every way, but the proportion here suggested is good. In any case it would be unwise to make a much larger table on the present lines.

For the top, the best plan is to buy a ready-made drawing-board—a deal one

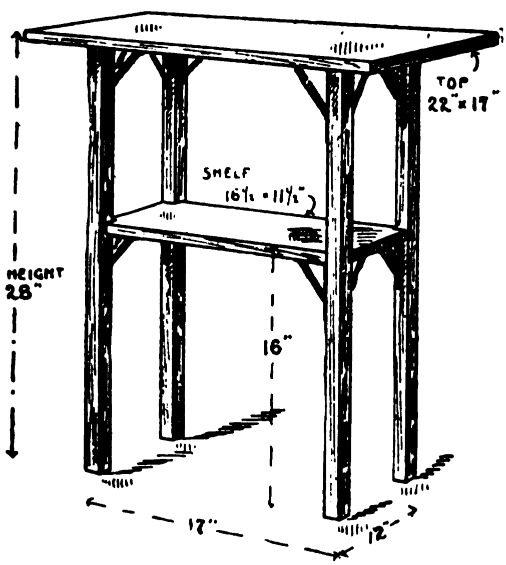
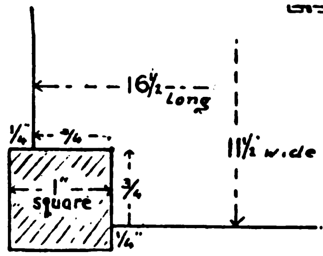


Fig. 1—The Finished Table



[Fig. 2—Corner of Shelf

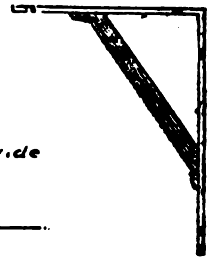


Fig. 3—Bracket

with clamped ends; 22 x 17 in. is a standard size. Pieces for the legs may also be bought, cut to 27½ in. long, and planed to finish 1 in. square. The shelf (½ in. thick) is cut at each corner, as in Fig. 2, in order to fit against the legs, the cut-away part being ¾ x ¾ in. It will thus be seen from Fig. 2 that the edges of shelf stand back ¼ in. from the face of legs.

Sixteen brackets, as illustrated at Fig. 3, are next required, two for each leg at the top and two for each at the shelf. Ordinary iron angle brackets must not be used; they are too ugly for such a table. The japanned-black stamped metal ones, as shown, should be asked for. A size approximately about 4 x 5 in. is suitable, and it will probably be found that each bracket is provided with five or six screw holes.

The positions of the brackets will easily be understood from Fig. 1. They are screwed to the two inner faces of each leg, special care being taken that the horizontal edges of each set of eight brackets are flush. If the shelf is ½ in. thick, the top edges of the lower eight brackets should be 15½ in. from foot of leg. These lower brackets, too, should be placed rather towards the inner corner of the leg, this because of the shelf being set in ¼ in., as shown at Fig. 2. Of course it is well not to fix all screws tightly until the top and shelf are placed in position.

The legs, with their brackets, are then placed in position in relation to top and shelf, and the latter screwed on. For the legs, ¾ in. screws may be used, but for the top or shelf only ⅝ in. ones are necessary. When it is seen that everything is square and true, all screws may

be driven in tightly. Should the table not stand steadily at first, it is easy to saw a shaving off the end of the faulty leg.

If the table is to be used for a lady's work the top will look best if covered with some dark green cloth material. If this is done the reader should first take the extra precaution to drive four 1½ in. screws through the top into the legs, taking care that the screw heads are filed off flush. The cloth is then stretched over the top, carefully brought over the edges, and tacked down underneath. If the shelf is to be similarly covered, this should be done before it is fixed on.

If the legs are stained, say walnut, and afterwards varnished, the table is one that can be used in any room. It is perhaps well to add that the writer is not merely describing an idea which has occurred to him. He has made several tables of the sort and has found them not only simple to construct, but of very great service.—*Handicrafts for Boys.*

Building a City to Order

"Not the least interesting thing in our trip down the Fraser," says Frederick Foster, writing in February *Canada Monthly*, "is the way some of the new British Columbia towns are being constructed ready for a population that hasn't yet arrived, and steel that is still some dozens of miles to the eastward. As Ed. and I canoed down the Fraser we saw one of these new towns in the making; with transit, chain and level, a score of engineers were laying out the town of Willow River with scientific precision.

"The novelty of seeing a 'town being made to order' appealed so strongly that I sought the Chief Engineer.

"'You are standing on the corner of the two principal streets of the future town,' he told me. 'The stake on which you just knocked the ashes from your pipe marks a lot which will be worth several thousand dollars a year or so from now.'

"Then with a blue-print spread before us he launched into the subject.

"'Here, at the crossing of these two streets, is where we are standing,' he explained. 'Four blocks down this way,' tracing the blue-print with his finger, 'will be the railway station and yards. This portion we are now surveying is the business portion only. When our work is finished, the plans must be registered at the government office, then the town is thrown open to settlement, or a better word is occupancy. For town building in Western Canada is much like skyscraper building in New York—everything made ready for the tenants to move in. As it is the wish of the railway company to make this one of the leading towns of Central British Columbia, the completion of our work is being looked forward to by merchants, manufacturers, home-builders and investors, who are anxious to get in at the beginning.'

"'Then you think that some day here will stand a city?' I asked.

"'Yes, there are many reasons why a city should rise here. There are seven billion feet of timber in the immediate vicinity waiting to be manufactured into lumber. The Willow River is an ideal logging stream and the boats on the Fraser can distribute the lumber manufactured here throughout central British Columbia, while the railway will carry it to the prairies. One of the largest coal deposits in the world lies a short way southeast; the Peace River country of the unlimited agricultural opportunities spreads to the north, and here at our door is an unlimited water power supply. So there you have it—manufacturing, mining, agricultural—a combination which puts cities on the map.'"—*Industrial Advocate.*

Time Signals from the Arlington, Va., Station

Since the tests of the Arlington, Va., station have been completed, that station is sending out the time signals twice each day. The signals are sent on a 2,500 meter wave, and are sent at noon and 10 p.m. Following the evening signal is sent a report of derelicts and other information useful for navigation. In addition to this the baseball scores are sent. These time signals are sent Sundays and holidays. This latter fact is very important, because until this time the coast naval stations have not sent the time on such days. As this station can be heard over the entire Atlantic coast and for a long distance at sea, it is proving very useful to navigation.

QUESTIONS AND ANSWERS

Questions on electrical and mechanical subjects of general interest will be answered, as far as possible, in this department, free of charge. The writer must give his name and address, and the answer will be published under his initials and town; but, if he so requests, anything which may identify him will be withheld. Questions must be written only on one side of the sheet, on a sheet of paper separate from all other contents of the letter, and only three questions may be sent at one time. No attention will be given to questions which do not follow these rules.

Owing to the large number of questions received, it is rarely that a reply can be given in the first issue after receipt. Questions for which a speedy reply is desired will be answered by mail if fifty cents is enclosed. This amount is not to be considered as payment for reply, but is simply to cover clerical expenses, postage and cost of letter writing. As the time required to get a question satisfactorily answered varies, we cannot guarantee to answer within a definite time.

If a question entails an inordinate amount of research or calculation, a special charge of one dollar or more will be made, depending on the amount of labor required. Readers will, in every case, be notified if such a charge must be made, and the work will not be done unless desired and paid for.

2015. **Transformer.** L. L. W., Toronto, Canada, asks: (1) Will you please tell me through *Electrician and Mechanic* the design of a transformer to operate on a 110 volt, 25 cycle supply and in the secondary to give 2, 4, 6, 8, 10 volts? (2) The amount of wire in pounds for same? (3) Is an iron core as good as anything else? Ans.—(1 and 2) Your request makes no mention of the size of transformer desired, so we cannot propose any explicit dimensions. We have published several articles on the construction of such for use on 60-cycle circuits; and the same general directions will hold for 25 cycles, except that you need about 25 per cent. greater section of the iron and 25 per cent. more turns of wire. After you have found out how many turns are required for the main winding that receives the 110 volts, you can easily determine how many turns are required for the other voltages for they will be directly proportional. This estimate, however, does not allow for voltage lost in the resistance of the coils, and you would need to admit perhaps 10 per cent. leeway. (3) Transformers for all purposes, except for certain wireless telegraph or kindred applications, require an iron core, and this should be well laminated as well as free from bolts and rivets.

2016. **Induction Coil.** Mr. W. F. M., Rochester, N.Y., asks: I have on hand ten coils of 35 s.c.c. wire of the following dimensions; Width 5-16 in., diameter of hole in center 1¾ in., wound to 2400 turns. I can obtain as many as twenty if necessary to make a good coil. I would like to wind a primary and make a core for same, so that it may be used on either 110 volts a.c. or 110 volts of batteries. (1) Could you please give me an idea of what the primary and core should be, also, the insulation for same? (2) What would be the spark length of this coil with 110 volts a.c.? This coil is to be used for X-Ray and wireless purposes. (3) What size condenser must I use across the interrupter? Ans.—It is quite problematical to state what the construction or output of the coil should be. So much depends upon the details of workmanship and materials that with the same weights of wire two constructors

bundle of fine iron wires about 1 in. in diameter in a fiber tube 1-16 in. thick. Over this wind two layers of No. 16 wire, then slip on a hard rubber or glass tube to fill the space between primary and secondary. Such a winding will be adapted for 10 to 12 volts direct current, and secondary may produce sparks 3 in. to 6 in. in length. Across interrupter contacts a condenser should be connected consisting of 100 sheets of tin-foil about 7 x 9 in. in size. If you desire to use the 110-volt supply, you will require finer primary wire, but the only sure method will be to try several different windings.

2017. **Selenium.** W. F. G., of San Francisco, Cal., asks: I would like to get information on selenium. (1) Are there any manufacturers of selenium in the United States? (2) Please give names and addresses also (3) where can I buy selenium in wire or ribbon, and are their any books on the above subject; please give names and publishers. Ans.—(1) Selenium is very brittle, and usually is sold in the form of pencils, of about the size of caustic soda sticks. (2) You can get it from Eimer & Amend, 205–211 Third Ave., New York, N.Y.

2018. **Potentiometer Trouble.** J. W. H. M., Coatesville, Pa., asks: I have not been successful in using a potentiometer with my detectors. I use perikon. When attempting to use potentiometer I cannot hear anything. It is wound non-inductively and has about 400 ohms resistance. I use a small flashlight cell. Can you give me connections that will work with the phones in series with detector. Phones are 2,000 ohms. Ans.—You are certainly using a very poor connection. Remove the phones from where they are now and place them in series with the variable slider on the potentiometer and the detector. Entirely remove the variable condenser you now have across the phones and go directly back to the tuner. You already have one stoppage condenser, which is quite sufficient.

2019. **Armature Winding.** B. B. B., Racine, Wis., says: Could you tell me where I can get information on how to figure the size and amount of wire to be used in winding an armature? I

would be very useful. Ans.—The comparison for direct-current cases is not difficult, for the number of turns of wire must be directly proportional to the voltage. For instance, if you had a 110-volt motor and desired to rewind it or a similar one for 220 volts, all you would have to do is to use the same weight of wire of half the cross section, *i.e.*, three numbers finer in the wire gauge, thereby getting on twice as many turns. Obviously the winding will be good for only half as much current. For the alternating-current case, the additional factors of self-induction and frequency come in, and no such simple rules can be given. If you have a 133-cycle 50-volt fan motor, and desire one for operation on a 110-volt 60-cycle circuit, you had better purchase a new one, for the old one cannot be fitted to operate at all economically. If only a matter of voltage is concerned, you can effect the change by putting about 25 per cent. to 40 per cent. more turns on the higher voltage machine. You ought also to increase the quantity of iron, but of course this cannot be done in the case of a motor already constructed. We do not know any book that will be so helpful for such small motors as these few simple directions coupled with your own experience. Of course in any specific case we may be able to offer more helpful suggestions.

2020. **Nib of a Saw.** L. X. S., Reno, Nev., asks: On the back of an ordinary carpenter's saw, about 3 or 4 in. from the end farthest from the handle is a kind of little knob. (1) Is it an ornament or not? (2) If it has a special use what is it? Ans.—If you talk with workmen you will get various ingenious explanations of the function of this feature, but the following extract from Henry Disston & Sons catalog seems entirely definite: "The 'nib' near the end of a hand saw has no practical use whatever; it merely serves to break the straight line of the back of blade, and is an ornamentation only."

2021. **Electrical Education.** J. E. T., Plessisville, P.Q., Can., asks if we have any books that will be helpful to him in becoming an electrical operator. An electrical sub-station is being equipped in his village, to which energy at 10,000 volts will be delivered by a power company. From this the current is to be distributed at about 110 volts pressure. He thinks there may be some chance for employment in caring for the apparatus. Ans.—You may be assured that the proper care of such electrical apparatus requires skilled attention, and the person entrusted with it will have had considerable training at the works of the manufacturing company. If the equipment was made in Canada, most likely it was from the works

direct current 110 volt. I want considerable force to stroke and rapidity coupled with extended use and small space occupied 6 in. or 8 in. Plunger or vibrating hammer, according to which is more powerful in striking. Ans.—Possibly Underhill's book on the Electromagnet will be helpful, but you must recognize the insulation-puncturing power of the counter electromotive force of self-induction exhibited at every break of the circuit. "Discharge" resistances, or their substitute, must be provided.

2023. **Education as Draughtsman.** E. C. S., Chicago, Ill., asks: What are the salaries which an auto repairer or overhauler receives? I am going to graduate from a technical high school in June and there have had some mechanical drawing. How long does it take to start at the bottom and work your way up to be a draughtsman? What is the average pay of a common draughtsman? Have also had machine and electric shop practice. Which trade has the most opportunities? Ans.—Quite a number of manufacturing concerns have courses definitely arranged for training young men for various engineering or administrative positions. A high school graduate should be able to take a course that will bring him a compensation of from 10 to 20 cents per hour, and at the end of three years land him in the drafting room. We would advise you to write to several of the automobile manufacturers in your vicinity or in Detroit, enquiring what opportunities they could offer.

2024. **Storage Battery.** W. W. B., of San Francisco, Cal., asks: Please tell me how I can charge the storage battery you mention on page 189 of the March number by James P. Lewis. Is there any way I can charge it from a 110 volt direct current circuit? Ans.—As the little battery has a capacity of only about ½ ampere, you can readily charge it by inserting it in the cord circuit of some regular incandescent lamp. The lamp will burn to less than full candle-power, but if the lamp is one ordinarily used in some corridor, its diminution in light will not be of much consequence. You will thereby get the charging for practically nothing. Be sure always to connect the same terminals, else you will reverse the polarity of cell, which ordinarily means loss and possibly ruin.

2025. **Photophone.** H. C. B., Grantsburg, Wis., asks: I desire to make for experimental purposes a working model of Bell's Photophone, in which he used transmitter, mirrors, selenium cell and lens for transmitting speech by beam of light

tion as to some later description you will be successful. We do not find advertisements of the parts in any of the scientific catalogs at our disposal.

2026. **Dry Cells.** J. F., of Paterson, N.J., asks: (1) What is the exciting paste in the Columbia dry cell? Please tell the proportions. (2) How can calcium chromate be made? (3) Is there any book on up-to-date makes of dry cells, and where can it be obtained? Ans.—Different manufacturers have different formulas, but these ingredients and proportions are not all the factors concerned in the operation of a successful battery. The method of assembling is of great importance. The preparation for a standard make of cells is: Oxide of zinc, by weight, 1 part; sal ammoniac, 1 part; plaster of Paris, 3 parts; chloride of zinc, 1 part; water, 2 parts. (2) Calcium chromate can be made by dissolving commercial chromium trioxide (chromic acid) *cautiously* in water and neutralizing with precipitated chalk or slaked lime. This will give an impure substance which would do for technical work, but if the pure salt is wanted it could be bought quite cheaply. (3) We can furnish you with a book on the subject by Norman H. Schneider for 25 cents.

2027. **Rectifiers—Transformers—Arc Lamps.** A. F. D., Whitman, Mass., asks: (1) Will you kindly explain to me the theory of the mercury arc rectifier. (2) The difference between a core type and shell type transformer. (3) Why is it that although they are all in series, that street lights, when broken or unscrewed from the base, do not break the circuit and put out the other lights? Ans.—(1) The complete theory is rather abstruse, and perhaps you are not asking for more than a popular description. Whatever be the theory, the mercury vapor possesses the peculiar property of permitting current to flow through it in one direction only. In other words, the vapor acts like a check-valve, permitting passage in one direction and not in the other. At one instant an impulse drives current in at one upper terminal and out of the bottom one, where the pool of liquid mercury is located. At the next instant the current being in the opposite direction, comes in at the other terminal, and also passes out at the bottom. The action is as if the pool were bombarded with current first from one electrode then the other. In order to tide over the instant when there is current passing in neither direction, there is a "sustaining" coil inserted in the direct-current circuit. In this circuit, the current is not entirely uniform, but is noticeably pulsating. (2) In the core type, illustrated by the familiar appearance of an electromagnet, the wire is mostly on the outside, and when you look at such a one, you see mostly wire. In this construction, the magnetic circuit is rather long, and subject to a certain amount of magnetic leakage, but the wire being on the exterior, has a good chance to keep cool. In the shell type, the wire is largely buried in the mass of sheet iron, and while giving much better magnetic conditions, shields the iron from the desired circulating air currents. The latest types of transformers gotten out by several of the manufacturing companies are attempts to utilize the good qualities of both constructions, the style made by the General Electric Company being denoted as the "Improved Type H." (3) Back of the ordinary screw portion of the lamp socket is another socket of the "pull" sort, between the two prongs of which is ordinarily an insulating bit of thin paper. When rupture of the circuit takes place, due to the breaking of a lamp filament, the sudden rise of voltage punctures this film and permits the prongs to come together. The act of withdrawing the whole socket permits the two strips with which the prongs make contact to come together, so the circuit is even then not broken. A new lamp is screwed into the socket, a fresh bit of paper placed between the prongs, and the new lamp readily and safely inserted in the circuit.

2028. **Magneto.** E. H. A., Sulphur Springs, Tex., says, or writes: I have a four-magnet, telephone-ringing magneto, practically new. (1) How should I wind a transformer to give from 50 to 75 volts from this little machine? (2) Should a three-prong armature motor, to be run on dry cells, have a three- or six-section commutator? (3) What effect does the size of the wire on field and armature windings of a small battery motor have? Ans.—(1) Such a machine when driven at an ordinary speed by means of the hand crank regularly gives about 75 volts, so you do not need to introduce a transformer. Please recognize that these machines are not adapted for continuous working, for the bearings are altogether too inadequate to give acceptable results for other applications. Then, too, the armature core is not always laminated, hence continuous use would result in considerable heat. (2) Three segments are all that this sort of winding permits. (3) The finer the wire, the slower the motor will rotate when operated at a certain voltage, or for the same speed, the higher voltage will the motor withstand. Of course, you will recognize that the finer the wire the smaller will be the permissible current, so for securing a given amount of work with a certain definite current, the voltage must be made sufficiently high.

2029. **Generator Winding.** H. D. P., of Watson, Ind., asks: I have a generator of the following dimensions which I wish to wind compound to give 7 volts. (1) What size and how much wire must be used? (2) Must it be double cotton-covered? (3) How many amperes will it give? Two poles 1¾ in. x 2¼ in., length 1 in., may be wound to a depth of ¾ in. Armature smooth-faced drum type 2¼ in. long, 1¾ in. diameter; commutator 11 segments. Ans.—In the absence of a sketch that would give sufficient dimensions for basing a calculation, we can only give a rough guess. Let armature have two layers of No. 20 wire—one layer for each half-winding. This even total number permits easily placed coils. If, however, you are familiar with such work, you may with good advantage place on three layers, but the odd number requires some skill. For the series portion of field winding, use one layer on each core of No. 16 wire, and fill the remainder of the space with No. 23.

2030. **Electromagnet.** E. E., Oakland, Cal., asks: Can you tell me how to make a magnet to operate a brake something like the sort used on the Otis elevator, to pull only one way, and about a 6 in. to work on 220 volts direct current. Ans.—Before we could propose anything definite

we would require more explicit specifications. Perhaps you will find Underhill's book on the "Electromagnet" of considerable value.

2031. **Motor Winding.** E. M., Cincinnati, O., asks for information as to correct sizes of wire for winding motor for operating a model electric car that fits a 7 in. gauge track. Field magnet is of cast iron, in one piece, one coil only being used. Armature core is laminated, 2 in. in diameter and 2 in. long, with 12 round holes, each 9-32 in. in diameter. Speeds between 1,200 and 2,000 revolutions per minute are desired, and the winding should be adapted for about 3.5 amperes at a pressure of 25 to 30 volts. Ans.—Explicit dimensions for the field magnet were not supplied, and in the design of a dynamo most of the calculations are based on that part of the machine. In consequence of the railway application, you should adopt a series winding, and the armature can have No. 21 wire and the field No. 18—all you can get on. Your suggestion that you prefer a wave winding is rather inappropriate, for this designation refers to windings for multipolar field magnets. In case of a two-pole field magnet you have no choice, and the winding is just as much "lap" as it is "wave."

2032. **Induction Motor.** W. D. S., Waterloo, Ia., asks: Enclosed you will find 15 cents for which please send me your March, 1913, back number, as I am very anxious to get Part I on "Induction Motors," as I consider it is the best treatise on that subject I have seen in some time. There is one part I wish you would explain in a letter to me, and that is the working of the ring on a single split phase-motor. The ring is attached to the rotor, opening and closing the aux. circuit. I do not know what ails mine; it will not start alone. I also have a flaming arc (no name on it), but made in Germany, which persists in feeding the carbon clear to the end and will not burn. Can you explain that to me, too? Ans.—From your description of the motor we should judge it was one of the Westinghouse Company's make, following the "Heyland" principle. If there is a name plate on it you will surely learn the identity of the maker, and then can do no better than to write to headquarters for information. If you have access to *Electrical World* for several years back, you should be able to locate the particular make of arc lamp from comparison with the various illustrations. If you succeed in this, it is a simple matter to write to the New York representative.

2033. **Connections for a Radio Station.** G. A. S., Laurium, Mich., asks: I would like to know (1) the best way to connect a wireless set, both transmitting and receiving. I have an electrolytic detector; fixed condenser; one 1,000 ohm Murdock receiver, and a 3-slide tuner. The transmitting set is composed of a spark gap; a 1 in. spark coil and vibrator; a helix, two pint Leyden jars; dry batteries 8 (or more if needed): a telegraph key. Aerial about 35 ft. high and 65 ft. long (4 wire), seven-strand No. 21 copper [illegible] D.P.D.T. switch. (2) How far [illegible]

side of the switch connect end and one slider of the tuning coil. Connect one of the other sliders to one side of the condenser, and from the other side of the condenser go to the detector, and from the detector go to the remaining slider on the coil. The phones go directly across the condenser. On the other side of the switch connect the bottom of the helix and one clip going to a point near the top of the helix. Put the Leyden jars in parallel and directly across the spark coil. Also from one side of the Leyden jars go to the spark gap and from the other side of the spark gap connect to a clip on the helix. Connect the other side of the Leyden jars to the third clip on the helix. (2) We can positively give you no authentic data on the subject. (3) The total capacity is equal to the sum of the separate capacities of the jars.

2034. **Wavemeter Inductance.** F. W. L., New York City, asks: I am constructing a wavemeter and wish to know the inductance in centimeters of the following coil to be used in conjunction with a Blitzen variable condenser; ten turns of No. 18 d.c.c. annunciator wire, wound on coil 6 in diameter. I have tried to figure it out according to the formula, but was unable to do so. Please advise as soon as possible the charges of this calculation and the desired payment will be sent. Ans.—You have not given us enough data to calculate the inductance of your coil. We have assumed that it has been wound in the form of a single layer solenoid. In that case the inductance would be 28,000 centimeters. Since you are to use this with a wavemeter, you should have your wavemeter calibrated or your inductance measured. The Bureau of Standards will measure your inductance for a small sum. If you are near an electrical laboratory, one of the assistants would probably measure it for you for a small charge.

2035. **Spark Coil.** F. H. R., Cleveland, O., asks: (1) Are the data for a ½ in. spark coil in Volume 23, page 213 of the *Electrician and Mechanic* correct? I have started to make a 1 in. coil and it is much smaller than the one detailed above. (2) Will you please give me the formula for resilvering mirrors? Ans.—The construction of spark coils is a very uncertain thing, and what one maker considers good another might completely reject. The data you refer to appear to be nearer a 2 in. coil rather than a ½ in. Perhaps a mistake was made in reading or setting up the title. If you have the data for a certain size of coil and have reason to believe that the data are correct do not be disturbed because another person gives different data for the same thing. (2) Unless you have a laboratory where you can work, it is very hard to do good work in silvering mirrors. You will find that the "reduction," which is the so-called cold process, to be the most convenient. In volume XVI of the Encyclopedia Britannica you will find a complete description of this process. There are several other processes given there also, but you will find the one suggested to give the best results in the hands of an amateur. Do not neglect to remove all [illegible]

If a condenser is used please tell number of sheets of tin-foil, etc. (2) Please describe a Tesla coil to use with above transformer, and what would voltage be of the Tesla coil? (3) Would a shock from the Tesla coil endanger the receiver's life? Ans.—(1) Connect two 2 m.f. telephone condensers in series directly across the line supplying your transformer. Ground the middle point of this pair of condensers and place a small spark gap across the terminals of each. These spark gaps should be set at 1/16 in. It would be far cheaper to buy the condensers than to make them. Such condensers if kept small, such as telephone condensers, would contain about 1,000 sheets of tin-foil each. These condensers can be purchased for about $1.50 each. The makers of your Blitzen transformer will furnish you with a complete protective device including line fuses for $5.00. (2) See article in the May, 1913, *Electrician and Mechanic*. (3) No.

2037. **Storage Batteries.** C. V. E., Divernon, Ill., says: I have a storage battery of 16 cells, 4 negative plates, 3 positive plates per cell, 120 ampere-hours capacity. The negative plates are Faure process, and the positive plates are Planté process. This battery was in use about 18 months, and plates were taken out of acid partly charged and boxed up after being washed. After being idle for eight months the battery was reassembled. The negative plates had sulphated badly in spots, and some of the positive plates had a sprinkling of sulphate, while some appeared all right. I have kept specific gravity down to 1.210 by drawing off acid and adding distilled water. I have been working this battery for about three months and have attempted to remove sulphate by giving repeated overcharges and keeping specific gravity down, but have only partly succeeded. I am not able to get over 40 ampere-hours out of battery. The active material in the negative plates seems too hard. How can I remove this sulphate and increase capacity? Ans.—It is commonly accepted that plates that are badly sulphated, especially if the sulphate is between the paste and the grid, are ruined, and that the cost of removing is more than that for new plates. Of the two methods ordinarily adopted for trying to remove the sulphate, you have evidently given one a thorough trial but without success. The other consists in temporarily reversing the battery. When discharged to a low degree, run out what little charge remains, and immediately begin charging in the reverse direction, whereby the negatives will be somewhat changed into positives, and as peroxide of lead is porous, this condition will be introduced into the "petrified" negatives. Use only a slow charging rate, else the outer plates will buckle. Even if they are somewhat distorted by the process, you can easily straighten them by pressing them between boards. A third method which has been recommended, but not yet demonstrated by us, is to remove the entire sets of plates from the acid solution, wash them and then assemble them in a weak solution of caustic soda, say of about 5 per cent. strength. Charge them at a slow rate. When the whiteness has disappeared, remove plates from the caustic solution, wash thoroughly, and transfer to the regular electrolyte. Perhaps you might try the process on a sample cell. If you do, please let us know the results.

2038. **Motor Winding.** O. W., Hartland, Me., sends a sketch showing a 7-prong rotor for a 4-pole motor, and asks for data for the winding. The rotor is 4¼ in. in diameter, and 1 in. long, axially; 15 volts are desired. Ans.—This is the most unusual design we ever saw, and we confess ignorance as how to proceed with it. Perhaps you have made some error in the sketch or the designer was not acquainted with the essentials of dynamo design. You did not state whether the rotor was laminated or if it was of solid iron. In case the latter supposition is true, there is no doubt that the structure is some crudity that can well be thrown into the scrap heap. Our magazine has regularly supplied designs for making dynamos of high order and economical working, and you do not need to content yourself with anything poorer.

2039. **Length of Sidereal Year.** F. F., Brooklyn, N.Y., desires to know the exact time required for the earth to make a complete revolution around the sun, and also desires to know the exact position of the earth in relation to the sun and the fixed stars as viewed from a point above the North Pole. Ans.—The length of the year varies slightly in accordance with the fixed point which is taken as reference. The tropical year, *i.e.*, from equinox to equinox, is 365.2421988 days. The sidereal year, or the absolute revolution, is 365.2563604 days. The anomalistic year, from perihelion to perihelion, is 365.2596413 days. It is probable that the second value is the one which you would desire for your calculations, and you can probably make these more easily with the length of the year expressed as a decimal fraction than if it were reduced to hours, minutes and seconds. In regard to the position of the earth in relation to the sun—the diagram you have sent does not show the actual state of facts, because the earth's axis is not perpendicular to its path around the sun, but inclined to it at an angle which is diminished annually by about ½ second of arc. The exact expression for the obliquity of the ecliptic is 23 degrees, 27 minutes, 8.26 seconds — 0.4684 seconds (t — 1900). In this expression "t" represents the date expressed in years and decimal fractions. For instance, April 1, 1913 would be approximately 1913.25, though three months is not exactly a quarter of a year. This obliquity of the ecliptic is what causes our seasons, and the North Pole of the earth is nearest to the sun at the summer solstice, which in 1913 is June 21st at 8.01 p.m., Washington mean time. So far as the position of the earth in regard to the fixed stars is concerned, the solar system occupies a position which may roughly be regarded as the center of an infinite number of stars fairly regularly distributed in every direction. The sun and its accompanying planets are moving rapidly through space in a direction of which you may find information in any standard text-book of astronomy.

2040. **Voltmeter.** A. F., Union Hill, N.J., says: (1) Will you kindly tell me how much resistance a d'Arsonval type voltmeter switchboard size requires outside instrument to give a reading up to 125 volts? (2) What size wire to use and should winding be non-inductive? (3) What kind of metal and what size to use for the shunt in ammeter, same type, center zero, to give a scale reading to 30 amperes each way.

Ans.—(1) We cannot give you any information without knowing more about the meter. The resistance of the meter and the volts necessary for full scale deflection must be known. If you have an instrument that you want to calibrate for a definite voltage, the best way to do is to try it out experimentally. For direct currents it is not necessary, but preferable, to have the winding non-inductive. (2) The wire would be about No. 34 copper. (3) The same applies to the ammeter; we must know the resistance of the instrument. The shunt should be of a metal that has a small change of resistance with temperature changes. There are various metals on the market for such purposes. If you have a standard instrument you can probably obtain the information you desire by writing to the makers. Be sure to send them the number of the instrument.

2041. **Electromagnet.** W. G., Klondyke, Can., asks: How can I construct an electromagnet to lift (for about a minute) 100 lbs. What weight of iron and what size and weight of copper wire are necessary? I can use 110 volts from the mains or any number of bichromate cells of large size which may be required. Can A.C. be used? Ans.—The problem cannot be solved without further specifications. The shape of the thing to be lifted must be stated, and also the space, if any, between the magnet and the other part. That is, what is the length of the air-gap? 100 lbs. is not a large amount for a magnet to "hold," but to start a weight when actual separation exists is quite another matter. Perhaps you will find helpful ideas and data in Underhill's book entitled "The Electromagnet."

2042. **Kick-backs.** E. H. S., Columbus, O., asks: I would be pleased to know if there are any on the market or whether it is possible to make a kick-back preventer that is absolutely reliable every time. What causes a kick-back? The power company claims that changing length of service wires on their system would cause it. Please give information if possible that will be satisfactory to the power company, as the success of the Club depends on putting in a transmitting outfit. Ans.—The Clapp-Eastham Co., Cambridge, Mass., supply a very effective protective device for kick-backs at a cost of $5.00. Since the success of your club depends on such a device we would advise you to write to them at once. It is possible that changing the length of the service wires would cause or prevent breakdowns, as such surges caused by the induced potentials are dependent on the length of the line.

2043. **Motor Construction.** G. E. M., Detroit, Mich., asks: I have built a motor as described in your September, 1911, issue. It has not the speed I think it should have. It also has very small power. I have carried out directions in every detail, but have designed a case for it. I have connected the windings in groups of six coils and reversed the current in alternate utterly discouraged with the outcome of my work. The mechanical part is all right, but the wiring or coils is absolutely rotten. Why, that motor hasn't as much power as a 1/8 h.p., let alone 1/2 h.p., as was stated in article. I am building this motor at Central High School, and intended using it to run a lathe we are making, but it would not run a sewing machine as it is. The starting coil described to go with it does not start it any better than you can by hand. It will not start it from a stand-still. I would like to hear from you as soon as possible so I can repair it before school closes this June. I would like a diagram of connections for these coils or a diagram of a new set giving number of turns and placement of coils to produce about 1,800 revolutions per minute. I also would like a drawing and description of a good starting coil or device. Ans.—Several of our readers have become confused in the construction of this motor, and we confess the diagrams were by no means clear. We advise you to rewind it, using "concentric" rather than "formed" coils. Such follow the famous "Heyland" motor, and if you can find some description of it you will be helped. As for a diagram you can most advantageously make it yourself. Number the slots consecutively from 1 to 24. Draw a coil occupying slots 1 and 6, but passing just outside of the intervening slots. Make a similar one between slots 7 and 12; also 13 and 18; finally 19 and 24. Then use No. 18 d.c.c. wire, pieces of curved 1/2 in. board being clamped over the intervening slots so as to prevent the wires from interfering with them. Wind the coils all alike, getting in as many turns as possible, and after winding them, bind cotton, not rubber, tape around them. Now wind a coil of the same size of wire in slots 3 and 4, and without cutting the wire continue it into slots 2 and 5. Wind similar coils in slots 9 and 10; 8 and 11. Similarly wind 15–16 and 14–17; finally, 21–22 and 20–23. Tape these groups. The four single coils first wound are the "starting," the rest the "running." Now in the former, connect the inner ends of coils 1 and 2, then the outer ends of coils 2 and 3, then inner ends of coils 3 and 4, finally leaving outer ends of 1 and 4 to be led to the binding-posts. Similarly, with the running coils, connect inner ends of groups 1 and 2, then outer ends of 2 and 3, inner of 3 and 4, with outer of 1 and 4 led to other binding-posts. Proof of the proper sequence of poles can be made with a direct current, and if this test is correct, the motor should run when using either winding alone, a start being, however, needed by hand, and only about half as much voltage used upon the starting winding as upon the running. After you have demonstrated this, you can put an extra inductance in the running winding, thereby increasing its already considerable lag in current, and putting ohmic resistance in the starting winding, thereby reducing its already less lag, whereby sufficient difference of phases may be

BOOK REVIEWS

Examples in Applied Electricity. By C. G. Lamb, M.A., B.Sc., A.M.I.E.E. Cambridge, at the University Press, 1912. New York, G. P. Putnam's Sons. Price, 70 cents net.

This is an excellent collection of problems in the mathematics of electricity taken from examination papers set to students in Cambridge University, in electrical and mechanical sciences. They are arranged in the form of thirty examination papers, each of eight questions, arranged in order of gradually increasing difficulty. Both electrical students and teachers will find this collection of problems of great value in practical study.

Practical Geometry and Graphics. A text-book for students in technical and trade schools, evening classes, and for engineers, artisans, draughtsmen, architects, builders, surveyors, etc. By Edw. L. Bates and Frederick Charlesworth. Contains a large number of practical exercises and answers, and about 600 illustrations. New York, 1912, D. Van Nostrand Co. Price, $2.00 net.

This book covers in a simple and practical manner the essentials of practical geometry and graphic, and is especially strong in its application of the principles of these mathematical sciences to the solution of problems often met in practical work. The book covers material which is intended for a two or three years' course of instruction, according to the capacity of the student; and the treatment is such that the pupil who is away from his teacher will be able by himself to get full benefit from the book. The instruction on plane geometry includes a good deal of mensuration and calculations relating to this extremely practical application of this science, and other chapters of practical treatment, especially on conic sections, much in excess of what is usually found in books on practical geometry. The chapters on graphics and descriptive geometry are also of the most practical nature; and while they go to the bottom of the pure mathematics, yet the applications are carefully worked out, and very complete.

American Telegraph Practice. A complete technical course in modern telegraphy, including simultaneous telegraphy and telephony. By Donald McNicol. New York, 1913, McGraw-Hill Book Co. Price, $4.00 net.

This beautifully printed volume of over 500 pages is a complete text-book to the modern practice of telegraphy in the United States, including all its applications and ramifications. There is no portion of the technical part of the subject which is not thoroughly covered in the most modern method, and a great deal of impr—

Steel. Its selection, annealing, hardening and tempering. This work was formerly known as "The American Steel Worker." It is the standard work on hardening, tempering and annealing steel of all kinds, being comprehensive and giving specific instructions as well as illustrations of the methods of hardening a large number of tools. All kinds of annealing muffle furnaces, blast ovens, open flames and the use of the lead and cyanide baths are fully described. Case hardening and pack hardening are treated in a comprehensive manner. A practical book for the machinist, tool maker, blacksmith, tool hardener or superintendent. By E. R. Markham. 4th edition. Fully illustrated. New York, 1913, The Norman W. Henley Publishing Co. Price, $2.50.

This new edition of a well-known book has been thoroughly revised, especially to cover the treatment of the various alloyed steels so much used at the present time in the manufacture of automobiles, gas engines and other modern apparatus. While many of the methods of handling these alloyed steels are held secret by the manufacturers, enough has been discovered about them to enable a valuable and thorough treatment of the subject in this book.

Practical Handbook of Gas, Oil and Steam Engines. Stationary, Marine, Traction Gas Burners, Oil Burners, etc. Farm, Traction, Automobile, Locomotive. A simple, practical and comprehensive book on the construction, operation and repair of all kinds of engines. Dealing with the various parts in detail, and the various types of engines, and also the use of different kinds of fuel. By John B. Rathbun. Chicago, 1913, Charles C. Thompson Co. Price: leather, $1.50; cloth, $1.00.

This very excellent and well-printed treatise fully lives up to the description contained on the title page, and is a complete and thorough handbook to the use of all kinds of engines in use at the present day.

NOTE

Mr. L. T. Hill, of Brookline, Mass., was the first amateur arrested under the "New Wireless Laws" in the New England District.

Radio Inspector H. C. Gawler filed a complaint with Commissioner Hayes, Department of Justice, Boston, Mass., wherein he stated Mr. Hill was operating an unlicensed radio station, and further complained Mr. Hill was not licensed as an operator of any radio station. Mr. Hill was requested to call at the Commissioner's office to answer the complaint and did so. He pleaded innocence of any intent to interfere, and was released on his personal bond to appear for a hearing

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Dynamo-Electric Machinery, by S. P. Thompson, with an introduction by F. L. Pope. Third edition, revised.

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MORGAN, ALFRED P.
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